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SCHOOL OF MINES AND METALLURGY

University of Missouri

BULLETIN

March, 1909

1908—CATALOGUE—1909

Rolla, Missouri

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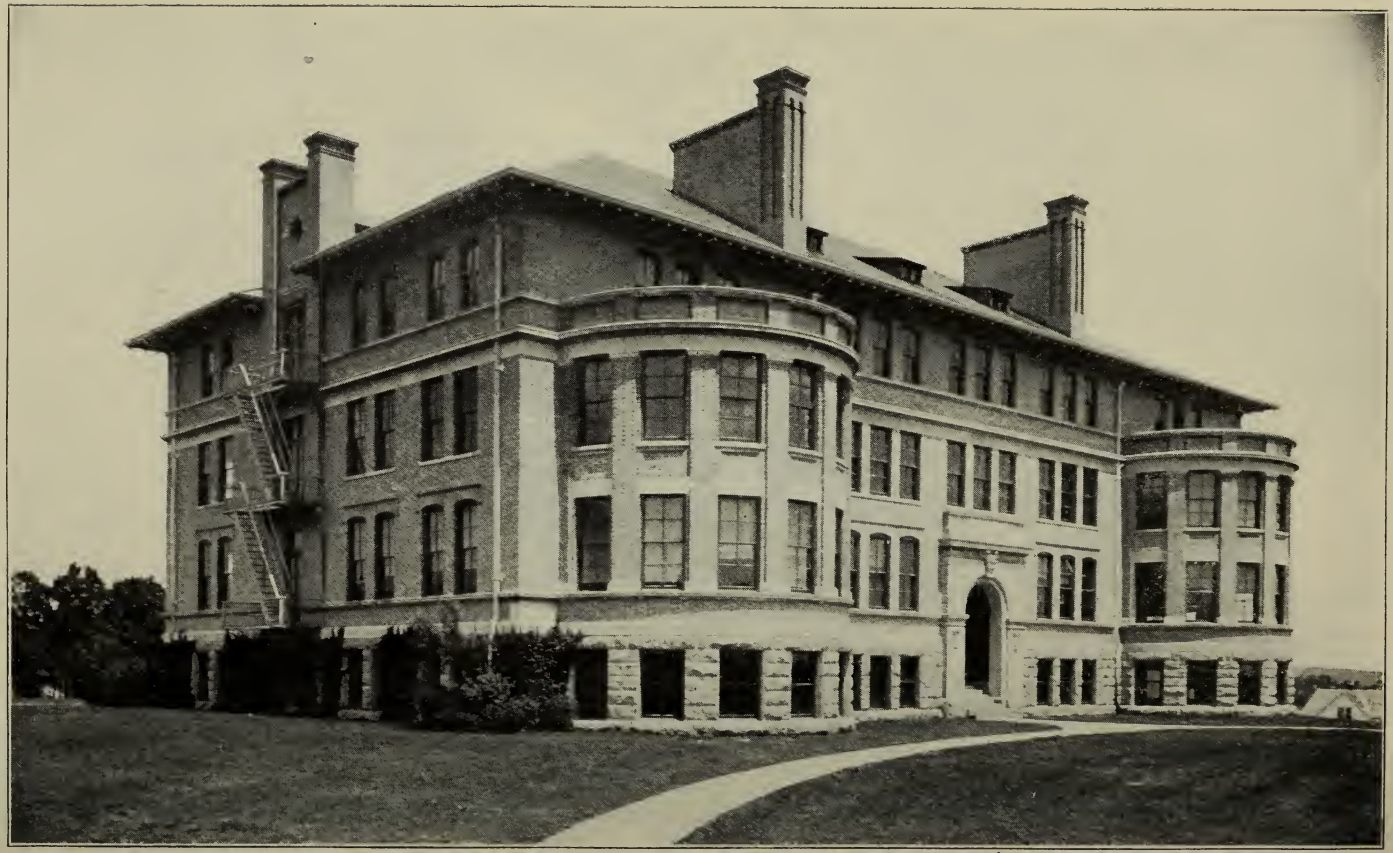

NORWOOD HALL

SCHOOL OF MINES AND METALLURGY

University of Missouri

THIRTY-EIGHTH ANNUAL CATALOGUE

Rolla, Missouri
1909

1909

JANUARY.

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11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

TABLE OF CONTENTS

CALENDAR.

1909.

March 22, Monday..... Third Term Begins.
June 9, Wednesday..... Annual Commencement.
June 14, Monday..... Summer School Begins.
July 24, Saturday..... Summer School Ends.
September 3, 4, Friday and Saturday ..... } Entrance Examinations.
September 6, Monday..... { Registration for First Term.
September 7, Tuesday..... First Term Begins.
November 25, Thursday..... Thanksgiving Holiday.
December 22, 4 P. M. Wednesday.. Christmas Recess Begins.

1910.

January 3, Monday..... { Registration for Second Term.
January 4, Tuesday..... Second Term Begins.
February 22, Tuesday..... Holiday.
March 12, Saturday..... { Registration for Third Term.
March 14, Monday..... Third Term Begins.
June 1, Wednesday..... Annual Commencement.

BOARD OF CURATORS.

S. L. Baysinger..... Rolla, Mo.
B. H. Bonfoey..... Unionville, Mo.
P. E. Burton..... Joplin, Mo.
C. B. Faris..... Caruthersville, Mo.
David R. Francis..... St. Louis, Mo.
J. V. C. Karnes..... Kansas City, Mo.
J. C. Parrish..... Vandalia, Mo.
Curtis B. Rollins..... Columbia, Mo.
Campbell Wells..... Platte City, Mo.

OFFICERS OF THE BOARD.

C. B. Faris..... President.
J. V. C. Karnes..... Vice-President.
J. G. Babb..... Secretary.
R. B. Price..... Treasurer.

EXECUTIVE COMMITTEE

of the

SCHOOL OF MINES AND METALLURGY.

C. B. Faris ..... Caruthersville.
J. C. Parrish ..... Vandalia.
P. E. Burton ..... Joplin.

OFFICERS OF THE COMMITTEE.

C. B. Faris ..... Chairman.
J. A. De La Vergne, Jr ..... Secretary.
Henry Wood ..... Treasurer.

Director of the School.
LEWIS E. YOUNG.

Secretary of the Faculty,
JOHN B. SCOTT.

Registrar,
J. A. DE LA VERGNE, JR.

Librarian,
JESSIE HELLER.

Superintendent of Buildings and Grounds,
ROBERT R. DICKERSON.

FACULTY.

ALBERT ROSS HILL, A. B., LL. D. *President of the University.*
A. B., Dalhousie University, 1892; Ph. D., Cornell University, 1895; LL. D., University of South Carolina, 1905; Dalhousie University, 1908.

LEWIS EMANUEL YOUNG, E. M. ..... *Director.*
B. S. in Mining Engineering, Pennsylvania State College, 1900; E. M., Iowa State College, 1904.

GEORGE REINALD DEAN, C. E. ..... *Professor of Mathematics.*
C. E., School of Mines, 1890; B. S. in Mathematics and Physics, School of Mines, 1891.

AUSTIN LEE MCRAE, S. D. ..... *Professor of Physics.*
B. S. University of Georgia, 1881; S. D., Harvard University, 1886.

VICTOR HUGO GOTTSCHALK, M. S. ... *Professor of Chemistry.*
B. S. in Chemistry and Metallurgy, School of Mines, 1898; M. S. School of Mines, 1900.

ELMO GOLIGHTLY HARRIS, C. E. ..... *Professor of Civil Engineering.*
C. E., University of Virginia, 1882.

DURWARD COPELAND, S. B. ..... *Professor of Metallurgy.*
S. B., Massachusetts Institute of Technology, 1903.

LEON STACY GRISWOLD, A. B. .... *Assistant Professor of Geology and Mineralogy.*
A. B. Harvard University, 1889.

JOSEPH HENRY BOWEN .. *Assistant Professor of Shop Work and Drawing.*
Graduate, Miller School, Va.

LEON ELLIS GARRETT, B. S. ..... *Assistant Professor of Mathematics.*
B. S. in General Science, School of Mines, 1901.

ROBERT CLAIR THOMPSON, M. S. .. *Assistant Professor of Chemistry.*
B. S., Westminster College, Pa., 1900; M. S., School of Mines, 1904.

FACULTY—Continued

PAUL JULIUS WILKINS, B. S..... *Instructor in Modern Languages.*
B. S., Michigan A. & M. College, 1869.

JOHN BENNETT SCOTT, B. S..... *Instructor in English and Secretary.*
B. S. in General Science, School of Mines, 1907.

EDWARD STAPLES SMITH, M. E.....*Instructor in Drawing.*
M. E., Brown University, 1904.

GEORGE WATSON COREY, E. M.....*Instructor in Mineralogy.*
B. S. in Mining Engineering, Michigan College of Mines, 1903; E. M., Michigan College of Mines, 1906.

BOYD DUDLEY, JR., B. S..... *Instructor in Metallurgy and Ore Dressing.*
B. S. in General Science, School of Mines, 1908.

DIBRELL PRYOR HYNES, B. S.....*Instructor in Chemistry.*
B. S. in General Science, School of Mines, 1908.

JAMES VANCE HOWE, B. S...*Instructor in Civil Engineering.*
B. S. in Civil Engineering, University of West Virginia, 1903.

HORACE THARP MANN, B. S.....*Instructor in Metallurgy.*
B. S. in Mining Engineering, School of Mines, 1908.

FRANK CRAIG LIVINGSTON, LL. B. *In Charge of Gymnasium Equipment.*

HECTOR GEORGE SYLVESTOR ANDERSON..... *Assistant in Metallurgy.*

DEFORREST DON.....*Assistant in Mineralogy.*
WILLIAM ALBERT BAUERIS.....*Assistant in Surveying.*
EDWARD PHILLIP BARRETT.....*Assistant in Chemistry.*
ARTHUR LEWIS POLLARD.....*Assistant in Physics.*
HARVEY ODEN GARST.....*Assistant in Surveying.*
ALBERT PARK.....*Assistant in Surveying.*
DAVID LAWTON FORRESTER.....*Assistant in Drawing.*

FACULTY COMMITTEES.

Admission.

Professors Dean, Wilkins, and Griswold.

Athletics.

Professors Thompson, Bowen, McRae, and Copeland.

Buildings, Plant, and Grounds.

Professors McRae and Harris.

Degrees.

Professors McRae, Scott, and Dean.

Examinations and Schedule.

Professors Bowen, Griswold, and Garrett.

Graduate Courses.

Professors Gottschalk and Copeland.

Theses.

Professors Harris, Copeland, and Griswold.

Undergraduate Courses.

Professors Dean, McRae, Griswold, and Gottschalk.

ROLLA BUILDING

HISTORY OF THE SCHOOL.

In 1870 the General Assembly of Missouri, in accepting the donation of land for educational purposes made by the General Government through an Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

Objects of the Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and the mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (R. S. 1899, Sec. 10504-10521.)

The School of Mines and Metallurgy was located at Rolla, Phelps County. Here, in November, 1871, the school was formally opened. The statutes fix the status of the School as one of the Colleges of the State University. Its affairs are under the immediate supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body. The need of general culture as a foundation and accompaniment of specifically technical training, led to the establishment, in 1885, of an Academic Course in compliance with the following Act of the General Assembly:

Academic Course of Study.—That the obligations of the State to the General Government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the State University shall prescribe and adopt a liberal Academic Course of Study to be taught in the College of Mines and Metallurgy, located at Rolla, in addition to the courses now taught in said school, and may confer the degree of Bachelor of Science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof. (R. S., Sec. 10504-10521.)

FINANCES.

The proceeds from the sale of the public lands granted by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent interest. The School of Mines receives one-fourth of the yearly income thus accruing.

By an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' the General Government donated to each State and Territory maintaining a college or colleges in accordance with the act of July 2, 1862, $25,000 a year. After deducting one-sixteenth of this fund for the Lincoln Institute, Missouri gives one-fourth of the remainder to the School of Mines.

In 1891, the Government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a 'direct tax.' The amount thus refunded to Missouri was $646,958.23, and the Thirty-sixth General Assembly of the State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University at Columbia, and the School of Mines and Metallurgy at Rolla. One-fifth of the income from this endowment, amounting to $6,469.58 per annum, is received by the School of Mines.

The Fortieth General Assembly of the State passed an act providing for a tax on collateral inheritances for the benefit of the State University, and the Forty-first General Assembly has provided that one-fifth of the funds derived from this tax shall be appropriated for the benefit of the School of Mines.

ENDOWMENT.

The State endowment of the School of Mines is set forth in the following extracts from the Statutes of Missouri:

"The proceeds of the sale of lands donated to the State of Missouri by the United States for the support of the College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy, by act of Congress, approved July 2, 1863, represented by state certificates of indebtedness, of the following amounts and dates:

July 2, 1883	$242,000.00
November 1, 1883	5,000.00
January 29, 1884	5,000.00
April 19, 1884	35,000.00
April 2, 1885	5,000.00
February 25, 1886	5,000.00
January 1, 1888	5,000.00
December 15, 1888	5,000.00
May 15, 1889	5,000.00
July 1, 1891	5,000.00
May 15, 1893	5,000.00
July 1, 1895	22,881.19
April 9, 1895	5,000.00
Representing a total of	$349,881.19

Now issued or any certificates which may hereafter be issued under any general or special act of the General Assembly; one-fourth of the interest of these funds shall be paid to the Treasurer of the School of Mines and Metallurgy, at Rolla, for the maintenance of said institution."

"The proceeds of sales of lands donated to the School of Mines and Metallurgy at Rolla, represented by the State certificate of indebtedness of $2,000, dated April 15, 1893, issued under act March 31, 1883, interest on which shall be applied to the maintenance of the School of Mines and Metallurgy at Rolla."

"The State certificate of indebtedness of $3,000, issued under act of April 1, 1895 (pages 278 and 281, Laws 1895), dated April 1, 1896, four-fifths of the interest to be applied to the maintenance of the State University at Columbia and one-fifth to the School of Mines and Metallurgy at Rolla, and also any other certificates which may hereafter be issued and held in trust for this fund under any general or special act of the General Assembly." (R. S. 1899, Sec. 10522.)

"The State certificate of indebtedness of $646,958.23, derived from 'direct tax' received from the United States, dated April 1, 1891, issued under act of March 26, 1891, four-fifths of the interest to be applied for the maintenance of the State University at Columbia, and one-fifth for the School of Mines and Metallurgy at Rolla." (R. S. 1899, Sec. 10522.)

"All sums collected under the provisions of an Act of Congress, approved August 30, 1890, commonly known as the 'Morrill Bill,' shall be paid as follows: One-sixteenth thereof for the benefit of the Lincoln Institute and one-fourth of the remainder to the Treasurer of the School of Mines at Rolla, Missouri." (R. S. 1899, Sec. 10533.)

Collateral Inheritance Tax.—"The moneys received by the State Treasurer under the provisions of this article shall be deposited in the State Treasury to the credit of the fund now existing in the State Treasury, and known as the 'State Seminary Moneys,' for the maintenance, support and better equipment of the buildings, apparatus, books, instruction, etc., of the University of the State of Missouri, to an amount not exceeding in any one year the equivalent of one-tenth of one mill for every dollar of the assessed valuation of taxable property of the State for the said year; **Provided,** that one-fifth of all such moneys so received shall be devoted to the use of the School of Mines and Metallurgy, a department of the said University." (Session Acts, 1901, Section 302.)

LOCATION.

The School of Mines is located at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco Railroad, approximately half-way between St. Louis and Springfield.

Rolla is on the crest of the Ozark uplift, at an elevation of eleven hundred forty feet above the sea level, and has an agreeable and notably healthful climate. Its position on a great transcontinental railway system makes it readily accessible.

The school is within easy reach of the important mining districts of the State, which offer splendid facilities for the study of mining geology, mining methods, ore dressing, and mining machinery. Numerous recent improvements, due to the systematic study of Missouri ore deposits, methods of ore treatment, and the extensive development of low-grade lead and zinc ores have given the school advantages for the application of the theories of geology, mining, and ore dressing to practice.

The smelting industry of the State is very important and every courtesy is extended to the professors and students of the school during their visits to these metallurgical plants. The methods of mining coal and clay can be readily studied in Missouri and the adjoining fields. Numerous clay-working and cement plants in St. Louis and the vicinity offer good opportunity for the study of these important industries. In and about St. Louis are also various chemical plants which are visited from time to time.

CAMPUS AND ATHLETIC FIELD.

The grounds of the School of Mines are situated in the highest part of the City of Rolla, and are over twenty-seven acres in extent. The campus contains beautiful lawns, groves of native oak, and many shade trees.

The athletic field has a good baseball diamond, a football gridiron, tennis courts, a 220-yard oval running track, and a 200-yard stretch for sprints and hurdles. On the athletic field there is a suitable building providing shower baths and a dressing room for the various athletic teams.

BUILDINGS.

Rolla Building.

This building was originally built by the City of Rolla as a High school building, but was sold to the State in 1871, and for many years was the principal building of the School of Mines and Metallurgy. It is a brick structure, ninety feet by sixty feet, four stories high, including a working basement. It contains the library, laboratories, drafting rooms, offices, and geological collections of the State Geological Survey, recitation rooms for mathematics and modern languages, toilet, shower baths, and locker rooms.

Chemical Hall.

The main portion of this building was erected in 1885 and two wings were added in 1902. The main building is two stories high and one hundred two feet in length by fifty-five feet in width. Each wing is fifty-five feet by sixty feet and one story high. This entire building, including a large basement, is used for chemistry.

Mining Building and Power Plant.

This building, erected in 1895, is a tile-roof, press-brick structure, and consists of two distinct portions, one containing offices, a class-room, and laboratories—the other comprising a large mill-room and mining laboratory, an engine-room, and a boiler-room. Suitable offices are provided in this building for the professor of mining engineering and for the superintendent of buildings and grounds.

Mechanical Hall.

This two-story brick building, erected in 1901, is one hundred fifty feet by sixty feet and was specially designed for mechanical work. The second floor includes a demonstration lecture room, a shop for bench-work in wood, and a temporary gymnasium. The first floor contains a lathe room for wood-turning, a forge room, a metal-working room, and a stock and tool room.

Each floor is provided with a lavatory and lockers and an office for the instructor.

Norwood Hall.

The corner stone of this building was laid November 23, 1902, and the building was first used in 1903. It contains adequate quarters for the demonstration offices, and provides lecture and recitation rooms for physics, geology, mineralogy, civil engineering, English, mathematics, also drawing rooms and laboratories for physics, geology, mineralogy, and civil engineering. The school library is located on the first floor of Norwood Hall.

Ore Dressing Building.

This is a three-story gray press-brick building, forty-five by one hundred six feet, with a basement and two large one-story wings. Although the building has not been completed, two stories and the west wing have been in use since January, 1908. The building is to provide quarters for metallurgy and ore dressing.

Director's Residence.

This is a two-story brick and frame building, erected in 1889 and used for a number of years as a student club-house and dormitory.

Athletic Building.

A one-story frame building, thirty-seven by thirty-four feet, formerly used as a wood shop, is now used by the athletic teams and provides dressing rooms, lavatory, and store room for athletic supplies.

Carpenter Shop.

The general repair work of the school and construction of laboratory equipment is carried on in a frame building, ninety feet by twenty-two feet. This building is located west of Mechanical Hall and includes a store room for lumber.

LIBRARY.

The Library contains about eight thousand carefully selected volumes and several thousand pamphlets and bulletins. Good collections of works on Engineering, Mathematics, Chemistry, Physics, Mining, Metallurgy, Ore Dressing, Geology, and Mineralogy, afford to students an opportunity to pursue an extended course of reading in connection with their class work. The Library also contains the standard works in English and American poetry, fiction, biography, and history. It is well provided with encyclopedias and works for general reference.

The Library is the depository for the maps, drawings, photographs, and lantern slides of the school. A splendid series of several thousand photographs of Missouri mines, mills, and smelters is on file and indexed so that it is easily accessible. Photographs have been secured from most of the important mining camps of the world, and the student has the opportunity to supplement the daily lectures by reference to these selected illustrations.

The valuable collection of between two thousand and three thousand maps and drawings are indexed and are used to supplement work in the class room and in the drafting room.

All of the important technical periodicals and reports are received regularly, together with general magazines which are of interest to engineers and scientists.

Current and recent technical literature plays such an important part in present-day education that an elaborate card index of technical literature has been provided and is maintained up-to-date. More than 25,000 important articles in transactions of societies, reports, bulletins, and periodicals have been recorded and classified.

A well-lighted room, thirty-nine feet by forty-five feet, has been furnished in an attractive manner for the reading room. It is located on the first floor of the building and is adjacent to the stack room.

The Library is open from 9 A. M. until noon, from 1 P. M. to 5 P. M., and from 7 P. M. to 9 P. M., daily except Sunday.

VIEW ON THE CAMPUS

ADMISSION.

Under the statutes persons of either sex, sixteen years of age or over, whether residents of Missouri or not, may be admitted upon evidence of sufficient preparation. Students should have a good liberal education, its elements at least, before beginning technical study. The average age of members of the present Freshman class at entrance was about eighteen years. Specific requirements have been fixed by considerations of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries. The requirements for admission to the Freshman class are as follows:

The applicant must file with the Director a satisfactory certificate of good moral standing.

Admission by Examination.—Applicants for admission, not having diplomas from approved schools, are required to pass, without conditions, examinations in fifteen units, a unit being the equivalent of a year's work in one subject, as given in an approved high school.

Of these fifteen units the following are required: Three units in English, two units in Algebra, one unit in Plane Geometry, and one-half unit in Solid Geometry. The remaining eight and one-half units may be selected from the following list:

Subject.	Maximum.	Minimum.
English	4	3
Algebra	2	2
Plane Geometry	1	1
Solid Geometry	½	½
Plane Trigonometry	½	½
History	4	1
Latin	4	1
Greek	3	1
German	3	1
French	3	1
Spanish	3	1
Physics	2	1
Chemistry	2	1
General Biology	2	1
Zoology	2	1
Botany	2	1
Drawing	1	1
Shopwork	1	1
Civil Government	½	½
Physiology	1	1
Physiography	1	1

Mathematics.—The four units which may be offered in mathematics are as follows:

Algebra. Two units. Elementary algebra, including the elementary operations, solution of simple and simultaneous linear equations, factoring, radicals, exponents, quadratic equations, equations containing radicals, imaginaries, simultaneous quadratics, higher equations solved as quadratics, relations of roots and co-efficients of quadratics and higher numerical equations, solution of higher equations by factoring, Horner's method of approximation, binomial theorem for positive integral exponent, ratio and proportion, and logarithms.

While the study of these particular subjects is recommended, it is not expected that the student shall be able to pass an examination on each and every one of them. He must produce evidence, however, of having studied algebra for two years under a good teacher in an accredited high school.

Plane Geometry. One unit. The work in Plane Geometry must cover a full year in any good text. It is recommended that considerable attention be paid to the applications of algebra to geometry, and of geometry to algebra and arithmetic.

Solid Geometry. One-half unit. A full half-year's work is required in Solid Geometry. The same recommendations apply here as in Plane Geometry, with the additional requirement that the student be drilled in arithmetical work in computing areas and volumes.

Trigonometry. One-half unit. It is to be understood at the outset that this work will not be accepted for advanced standing. This branch of mathematics is of such great importance to the practical engineer that the whole subject must be reviewed, and the student led to a point of view which it is impossible to attain in a high school course.

History.—Four units may be offered in history; one each in Ancient History, Medieval and Modern History, English History, and American History.

Civil Government. One-half unit may be offered in Civil Government. This is the equivalent of one-half year's work in the fourth year of a high school and the applicant should have a knowledge of the chief organs of local, state, and national government, and a knowledge of the historical development of the government.

Physiography.—A student may offer one unit in physiography. A description of this unit will be sent on request.

Physics.—The two units that may be offered in physics are as follows:

1. A year's work, five periods per week, of which at least two must be double periods in individual laboratory work. At least thirty-five exercises, selected from a list of sixty or more, equivalent to those recommended by the National Educational Association, must be completed.

2. A continuation of the laboratory for another year, or a year's work in a more advanced text together with the laboratory work.

Laboratory note-books must be presented by those who are required to take the entrance examination.

Drawing.—One unit may be offered in drawing and is as follows:

A year's thorough work in freehand drawing, or in mechanical drawing, or in a combination of the two. This unit is the equivalent of five laboratory periods per week throughout the year. Drawings must be presented by students desiring credit in this subject for entrance. This unit will be accepted for admission but not for advanced standing.

Freehand. The ability to draw and paint natural growths (leaves, flowers); to give correct proportions, perspective, and light and shade in drawing from geometric solids, vases, etc.; to paint with water colors from simple objects (fruit vases); to make designs suitable for book covers and school programs, in black and white and in color.

Mechanical. Use of instruments and plain lettering; simple geometrical problems; plain freehand lettering and di-

mensioning; plans, elevations, and cross-sections; development of the *idea of plan, elevation* and *section* from geometrical solids; drawing accurately to scale plans, elevations, and sections from pupil's own measurements; and dimensioned freehand sketches of simple machine parts; plan and elevation of some building measured by pupils. The explanation and practice of isometric and cabinet views as applied especially in joinery.

Combination. The ability to draw, as outlined under the Freehand Course, without the painting; the use of the instruments, plain lettering, the drawing of simple plans and elevations as outlined under the Mechanical Course.

Manual Training.—One unit may be offered in manual training and the candidate must give satisfactory evidence of having completed a year's work of five periods per week of at least one and one-half hours each. This work will not be accepted for advanced standing.

Latin.—The four units that may be offered in Latin are as follows:

1. Collar and Daniell's First Latin Book, or the equivalent.
2. Three books of Caesar's Gallic War with composition based thereon in Moulton and Collar's Preparatory Latin Composition or in Daniell's New Latin Composition. For one book of the Gallic War the equivalent in time of Viri Romae, Nepos, or Eutropius may be offered.
3. Two additional books of the Gallic War and four Orations of Cicero with compositions based thereon in the books mentioned above.
4. Ovid's Metamorphoses (2,000 lines) and four books of Vergil's Aeneid, with prosody.

Greek.—The three units that may be offered in Greek are as follows:

1. Ball's Elements of Greek, or White's First Greek Book.

2. Four books of Xenophon's Anabasis, Pearson's Greek Prose Composition, or its equivalent, Goodwin's Greek Grammar.

3. Ten orations of Lysias and the first four books of Homer's Odyssey, or an equivalent amount of other Greek authors. Bridgman's Parallel Exercises based on Lysias.

German, French, Spanish.—Three units may be offered in German, French, or Spanish. A description of the units will be sent on request.

Chemistry.—The two units that may be offered in chemistry are as follows:

1. A year's work in chemistry, five periods per week, of which at least two must comprise laboratory work.

2. A second year's work in the subject, five periods per week, of which at least two must be laboratory work.

Note-books showing work done must be presented by those who are required to take the entrance examination.

These courses will be accepted for admission but not for advanced standing.

Admission on Diploma.—Applicants may be admitted upon certificate from a college, high school, or preparatory school when the Faculty is satisfied that the work certified to covers the requirements of the School of Mines and Metallurgy.

Each applicant must file with his diploma a statement, on a School of Mines and Metallurgy blank, from his superintendent or principal, showing that the applicant has to his credit fifteen units.

Following is a list of schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman class without examination.

ACCREDITED SCHOOLS.

Albany High School
Alton (Ill.) High School
Appleton City Academy
Aurora High School
Bartlesville (Okla.) High School
Bethany High School
Blees Military Academy, Macon
Bloomfield High School
Bonne Terre High School
Boonville High School
Braymer High School
Breckinridge High School
Brookfield High School
Butler High School
Cairo (Ill.) High School
California High School
Cameron High School
Carleton College
Carrollton High School
Carterville High School
Carthage High School
Caruthersville High School
Centralia High School
Charleston High School
Chillicothe High School
Clinton High School
Columbia High School
Covington (Ind.) High School
Culver (Ind.) High School
Davenport (Ia.) High School
De Soto High School
Dexter High School
Doniphan High School
East St. Louis (Ill.) High School
Elmwood Seminary
Enid (Okla.) High School
Everton High School
Excelsior Springs High School
Ferguson High School
Flat River High School
Fort Scott (Kan.) High School
Fort Smith (Ark.) High School
Fredericktown High School
Gallatin High School
Grant City High School
Greenfield High School
Greenville (Miss.) High School
Guthrie (Okla.) High School
Hamilton High School
Hannibal High School
Hardin College, Mexico
Harrisonville High School
Higginsville High School
Hopkins High School
Hot Springs (Ark.) High School
Iberia Academy
Independence High School
Jackson Military Academy
Jefferson City High School
Joplin High School
Kahoka High School
Kansas City (Kan.) High School
Kansas City Central High School
Kansas City Manual Training School
Kemper Military Academy, Boonville
Kennett High School
Keokuk (Ia.) High School
Kewanee (Ill.) High School
King City High School
Kirksville High School
Kirkwood High School
Lamar High School
Lancaster High School
La Plata High School
Leavenworth (Kan.) High School
Lebanon High School
Lee's Summit High School
Lexington High School
Liberty High School
Linneus High School
Lockwood High School
Logan County High School (Guthrie, Okla.)
Louisiana High School
Macon High School
Maitland High School
Malden High School

Marionville Collegiate Institute
Marshall High School
Marvville High School
Memphis High School
Mexico High School
Michigan Military Academy (Orchard Lake, Mich.)
Milan High School
Missouri Wesleyan College
Moberly High School
Montgomery City High School
Mound City High School
Mt. Vernon High School
Muskogee (Okla.) High School
Nevada High School
Norborne High School
Oklahoma City (Okla.) High School
Oregon High School
Palmyra High School
Paola (Kan.) High School
Paris High School
Pierce City High School
Pine Bluff (Ark.) High School
Poplar Bluff High School
Princeton High School
Quincy (Ill.) High School
Rich Hill High School
Richmond High School
Ridgeway High School
Rogers Academy (Rogers, Ark.)
Rolla High School
St. Charles High School
St. Charles Military Academy
St. Joseph High School
St. Louis Central High School
St. Louis McKinley High School
St. Louis Manual Training School
St. Louis Yeatman High School
Savannah High School
Sedalia High School
Shelbina High School
Shelbyville High School
Sikeston High School
Slater High School
Smith Academy
Springfield High School
Steelville High School
Sweet Springs High School
Tipton High School
Trenton High School
Troy High School
Tulsa (Okla.) High School
Unionville High School
University Military Academy (Mobile, Ala.)
Vandalia High School
Walther College, St. Louis
Warrensburg High School
Washington High School
Webb City High School
Webster Groves High School
Wellston Station High School, St. Louis
Wentworth Military Academy, Lexington
West Plains High School
Western Military Academy
Westport High School
William Woods College, Fulton
Windsor High School

Advanced Standing.—Candidates may be admitted to advanced standing either upon examination in the subjects of the previous year or years, or upon certificate from another institution, of work accomplished, which is, in the estimation of the Faculty, equivalent to that completed here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible, and all claims for advanced standing, in order to receive recognition, must be made by the student within one term after entrance.

Special Students.—Special students will be admitted without passing the regular examinations required for entrance, under the following conditions: 1. They must be at least twenty-one years of age. 2. They must show good reasons for not taking a regular course. 3. They must pass such examinations or other tests as shall demonstrate fitness to pursue profitably all the subjects selected by them. 4. They shall not be candidates for a degree. 5. Special students are expected to do particularly good work in the subjects which they choose. If, at any period of the session, their work becomes unsatisfactory, their connection with the school will be severed. When the work is chiefly of a laboratory nature they will be required to take at the same time as much classroom work as the Faculty may designate for each particular case.

Since there are many persons who would profit by the opportunities for education offered at the school, but who are unable, through lack of time or preliminary training, to undertake the work of the regular course, the Faculty has made the above provision. In this way it hopes to broaden the usefulness of the school, and to enable it to fulfill its purpose in as liberal a manner as possible.

DEGREES.

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Metallurgy, or Bachelor of Science in Civil Engineering, will be conferred on students who have attained the required standard in all the subjects of instruction in Courses I., II., or III., and who submit satisfactory thesis.

2. The degree of Bachelor of Science will be conferred on students who have satisfactorily completed Course IV., and who submit a satisfactory thesis.

3. The degree of Master of Science will be given to students who, having graduated in Course IV., complete satisfactorily a year's post-graduate work in residence at the school, and demonstrate their ability by research work and a thesis.

4. The degree of Engineer of Mines, Civil Engineer, or Metallurgical Engineer, will be conferred on one who, having previously been graduated in Course I., II., or III., has completed satisfactorily a year's post-graduate work in residence, or who has had professional experience in a responsible position for not less than three years. A satisfactory thesis recording the result of some original investigation or independent research in a subject connected with his course, accompanied by such drawings as may be necesary to illustrate it, are required of all candidates for advanced degrees.

THESES.

All Seniors carry on special investigations during the third term and the results of this work are embodied in a thesis. The subject of the thesis must be reported to the Thesis Committee and approved not later than February 1st and the completed thesis filed with the Director not later than May 20th. The finished thesis must be typewritten on eight and one-half by eleven-inch paper with a one and one-half inch margin on the left to permit of binding in book form.

COURSES OF STUDY.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation by acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged for the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. What is taught orally in the lecture room is applied and illustrated in the laboratory.

The School of Mines offers four regular courses leading to degrees.

I. *Mining Engineering.*
II. *Metallurgy.*
III. *Civil Engineering.*
IV. *General Science.*

The first is a general course in Mining Engineering having in view all of the operations in connection with mining, from the prospecting to the delivery of the finished product on the market. Instead of the regular work outlined for the Senior year in the Mining Engineering course, a student who has satisfactorily completed the work of the first three years of this course may elect one of the three optional courses outlined on pages 36, 37, and 38. These options are in Mining Geology, Mining Machinery, and Ore Dressing. They are planned for men who desire to specialize in the particular subjects mentioned and all lead to the degree of Bachelor of Science in Mining Engineering.

The second course contemplates especially processes in metallurgy subsequent to the delivery of the ore above ground. It fits a man for positions in connection with concentrating plants and smelters and various branches of industrial chemistry.

The third is a course in engineering as applied especially to railways, highways, and municipal works.

The fourth is largely elective and provides for a liberal education in General Science.

The engineering courses are practically the same in the Freshman year, and differ but slightly in the Sophomore year, The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

One hour is given to each recitation or lecture period. The afternoon periods are given to drawing, laboratory, and field work and are of three hours' duration.

SPECIAL COURSES.

In addition to the four regular courses leading to degrees, mentioned above, a number of shorter courses are also offered. They are: *Chemistry and Assaying, Mining, Surveying and Electricity.* They have been planned for the benefit of those who, for various legitimate reasons, are unable to take the regular four-year courses.

The course in *Assaying and Chemistry* requires two years' work, although mature students, who have already some knowledge of chemistry, may complete it in one year. For description see page 44.

The purpose of the course in *Surveying* is to develop competent land and mining surveyors and fair draftsmen. The essentials of it are a thorough knowledge of algebra, trigonometry, surveying, field practice, and drawing. One school year and the first term of a second, will be required for the completion of this course.

A two-year course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Enginering. Besides mathematics this course includes general chemistry, assaying, mineralogy, geology, mining, surveying, and English.

A course in *Electricity* is offered to furnish the student with the theory of electricity, and acquaint him with its application in the arts. This subject is of great importance to every engineer, especially to the mining engineer, since electricity has become such an important factor in mining operations.

See remarks on special students, page 26, and outline of special courses beginning page 44.

SUMMER SCHOOL.

In order to provide an opportunity for students to make up deficiencies, certain laboratories are open for six weeks during the summer. Applicants for admission to advanced standing are frequently deficient in mineralogy and advanced chemistry; by attending the summer school they can generally arrange a more satisfactory schedule for the college year.

All of the courses will be given in the laboratories at Rolla. The summers at Rolla are delightful, Rolla being located in the Ozarks at an elevation of eleven hundred forty feet. Many visitors spend the summer annually at Rolla because of the pleasant weather of the months of June and July.

Courses Offered in 1909.

Assaying.—This course is a duplicate of the regular course in fire assaying, given during the regular college year. A complete description of this course is given under Metallurgy and Ore Dressing on page 71. Students taking the summer course in assaying who are candidates for degrees will be given credit for both lectures and laboratory work.

Twenty-four hours per week for six weeks.

Metallurgy Laboratory.—This course is a duplicate of Course M-13 as described on page 81. Full credit will be given for the work as required for the degree of Bachelor of Science in Mining Engineering in the laboratory work and in Metallurgy Conference, M-12, as described on page 81 under Metallurgy and Ore Dressing.

Fifteen hours per week for six weeks.

VIEW ON THE CAMPUS

Qualitative Chemical Analysis.—The work in qualitative analysis is a duplicate of Course 3 in Chemistry as described on page 53. Any student completing the entire summer course will be given credit for the qualitative lectures and two terms qualitative laboratory.

Twenty hours per week for six weeks.

Quantitative Chemical Analysis.—This is a duplicate of Course 4 described under Chemistry on page 53. Students who finish this summer course will be credited for two hours quantitative lectures and for all of the quantitative laboratory required for mining engineers.

Thirty hours per week for six weeks.

Mineralogy Laboratory.—The student who completes the summer work in mineralogy will be given credit for two of the three terms' work in crystallography and mineralogy required for the degree of Bachelor of Science in Mining Engineering. This course is described as Course 1 under Geology and Mineralogy on page 72.

Twenty-four hours per week for six weeks.

Mining.—This course includes lectures on prospecting, drilling, blasting, boring, tunneling, shaft-sinking, mining methods, supporting excavations, and mine timbering. The student who completes the summer course in mining will be given credit for elementary mining described on page 68 under Mining Engineering as Course 1, and also Course 3 in Mining Engineering.

Six lectures per week for six weeks.

Equipment.

The laboratories of the school are thoroughly equipped in every particular and the equipment used in the regular course is open to summer students. Detailed description of the equipment will be found under the description of laboratories in the several courses.

Fees.

For the summer school of 1909 every student who enrolls will be required to pay the registration and tuition fees and to make the contingent deposit. In addition each student will pay the regular laboratory fees for such courses as he elects.

Registration Fee	$ 5.00
Tuition Fee	5.00
Contingent Deposit	10.00
Assay Laboratory Fee	25.00
Qualitative Laboratory Fee	15.00
Quantitative Laboratory Fee	3.50
Mineralogy Laboratory Fee	6.00
Metallurgy Laboratory Fee	5.00

A special circular describing summer courses will be sent on request.

EXCURSIONS.

Required.

A.—At the close of the Sophomore year, three weeks of summer field work for practice in topography and lines of communication is required of students in Civil Engineering. This work is carried on in the vicinity of Rolla.

B.—At the opening of the school year, in September, one week's field work in Topography by all Juniors not taking A.

C.—At the close of the Junior year, students in Mining and Metallurgical Engineering make a three weeks' excursion to southeast Missouri, for practice in mine surveying and the study of field and economic geology, mining, and ore dressing.

D.—During the Senior year a one week's trip to southwest Missouri, particularly the Joplin district, for the study of ore deposits, mining methods, and ore dressing.

E.—Excursions by the Senior class to Steelville, Sligo, DeCamp, Meramec, Newburg, and Sullivan for the purpose of studying iron, copper, lead deposits, and methods of reduction. This excursion takes place during the latter part of the Senior year.

F.—An excursion by the Senior class to Herculaneum, St. Louis, Granite City, and the coal fields of Illinois. This excursion is during the latter part of the Senior year.

Voluntary.

In addition to the foregoing trips which are required in the various courses, a number of optional excursions can be made under the supervision of the members of the Faculty. These excursions are planned for students who have finished the work of the Junior year and may be made to the following mining districts:

1.—Southern Appalachian District where geology, mining, and metallurgy may be studied, particularly in the mining districts of Birmingham, Ala., and Ducktown, Tenn.

2.—Copper mining districts of the Southwest, particularly Bisbee, Ariz., and Cananea, Mexico.

3.—Lake Superior mining district including the copper and iron ranges of Michigan and the iron ranges of Minnesota.

4.—Metal mining districts of Colorado, Utah, and Montana.

COURSE I.—MINING ENGINEERING

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry } Analytical Geometry }	0	0	5
Descriptive Geometry	0	2	2
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	0	0
Mineralogy	0	0	2
LABORATORY WORK:			
General Chemistry	3	3	3
Drawing, Mechanical	6	6	6
Descriptive Geometry Drawing	0	3	3
Shop Practice	6	6	0
Mineralogy Laboratory	0	0	6
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry } Differential Calculus }	5	0	0
Spanish, German, or French	5	5	5
Advanced English	1	1	1
Integral Calculus	0	5	0
Differential Equations	0	0	5
Mineralogy	2	0	0
Lithology	0	2	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
Mining	0	2	3
Elementary Mechanics	0	2	0
General Physics	0	0	5
Qualitative Analysis	0	2	0
LABORATORY WORK:			
Forge Shop or Machine Drawing	6	6	6
Mineralogy	6	6	0
Lithology	0	3	0
Surveying Field Practice	6	0	0
Qualitative Analysis	0	6	6
Physics	0	0	6
Topography, one week between the Sophomore and Junior Years.			

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR			
LECTURES AND RECITATIONS:			
General Physics	5	0	0
Thermodynamics	0	5	0
Mechanics of Engineering	5	0	0
Mechanics of Materials	0	5	0
Hydraulics	0	0	5
General Geology	5	3	5
Quantitative Analysis	2	0	0
Assaying	2	0	0
Metallurgy	0	3	3
Masonry	0	2	0
Lines of Communication	0	0	2
Elements of Ore Dressing	0	0	3
LABORATORY WORK:			
Physics	6	0	0
Steam	0	3	0
Assaying	6	6	0
Quantitative Analysis	6	9	0
General Geology	0	3	6
Drawing and Graphics	0	0	6
Lines of Communication	0	0	3
Hydraulics	0	0	3
Excursion to Southeast Missouri.			
SENIOR YEAR			
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Metallurgy	4	4	4
Metallurgy Conference	0	1	0
Economic Geology	3	3	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Frame Structures	2	0	0
Hydraulic Motors and Pumps	0	0	1
LABORATORY WORK:			
Ore Dressing	6	0	0
Ore Dressing Problems	0	3	3
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Metallurgy	0	7	0
Compressed Air	0	3	0
Thesis	0	0	6
Senior Trips.			

MINING GEOLOGY OPTION

SENIOR YEAR

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Economic Geology	3	3	5
Petrography	3	3	2
Geology of the United States	3	0	0
Structural and Metamorphic Geology	0	0	3
Paleontology or Metallurgy	4	4	0
Historical Geology or Metallurgy	0	0	4
Geological Conference	0	2	0
Ore Dressing	4	0	0
Mining Law and Contracts	2	0	0
Methods of Prospecting and Mine Development	0	3	0
Mine Management	0	0	2
Elective Geology	0	0	3
LABORATORY WORK:			
Geology	3	6	6
Petrography	9	6	6
Ore Dressing	6	0	0
Paleontology or Metallurgy	0	6	0
Thesis	0	0	6
Senior Trips.			

MACHINE SHOP

MINING MACHINERY OPTION

SENIOR YEAR

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	0	0	1
Mining Machinery	0	4	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Hydraulic Motors and Pumps	0	0	1
Mine Management	0	0	2
Mining Law and Contracts	2	0	0
Economic Geology	3	0	0
Metallurgy	4	4	0
Metallurgy Conference	0	1	0
Frame Structures	2	0	0
Cement and Concrete Structures	0	0	2
LABORATORY WORK:			
Mining Machinery	3	9	0
Mining Machinery Problems	0	0	6
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Ore Dressing	6	0	0
Metallurgy	0	4	0
Compressed Air	0	3	0
Thesis	0	0	6
Senior Trips.			

ORE DRESSING OPTION

SENIOR YEAR

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
LECTURES AND RECITATIONS:			
Ore Dressing	4	4	4
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Metallurgy	4	4	4
Metallurgy Conference	0	1	0
Economic Geology	3	3	5
Dynamo Machinery	3	0	0
Alternating Current Machinery	0	5	0
Electrical Transmission	0	0	3
Compressed Air	0	2	0
Frame Structures	2	0	0
Hydraulic Motors and Pumps	0	0	1
LABORATORY WORK:			
Ore Dressing	9	0	6
Ore Dressing Problems	0	3	3
Graphics	3	0	0
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	6	0
Electrical Problems	0	0	3
Metallurgy	0	7	0
Compressed Air	0	3	0
Thesis	0	0	6
Senior Trips.			

COURSE II.—METALLURGY

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry / Analytical Geometry	0	0	5
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	0	2	2
Elementary Mining	2	0	0
Mineralogy	0	0	2
Qualitative Analysis	0	2	0
LABORATORY WORK:			
General Chemistry	9	0	0
Mechanical Drawing	6	6	6
Qualitative Analysis	0	9	6
Mineralogy	0	0	6
Descriptive Geometry	0	3	3
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry / Differential Calculus	5	0	0
Integral Calculus	0	5	0
Differential Equations	0	0	5
German, French, or Spanish	5	5	5
Elementary Mechanics	0	2	0
Advanced English	1	1	1
General Physics	0	0	5
Lithology	0	2	0
Quantitative Analysis	2	2	2
Surveying, Plane	3	0	0
Mineralogy	2	0	0
LABORATORY WORK:			
Field Practice	6	0	0
Quantitative Analysis	6	9	12
Mineralogy	6	6	0
Lithology	0	3	0
Physics	0	0	6

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
Assaying	2	0	0
General Geology	5	3	5
General Physics	5	0	0
Mechanics of Engineering	5	0	0
Chemical Memoirs	2	0	0
Electro-Chemistry	0	2	3
Mechanics of Materials	0	5	0
Hydraulics	0	0	5
Elements of Ore Dressing	0	0	3
Metallurgy	0	3	3
Physical Chemistry	0	2	0
Thermodynamics	0	5	0
LABORATORY WORK:			
Assaying	6	6	0
Geology	0	3	0
Field Geology	0	0	6
Physics	6	0	0
Quantitative Analysis	6	0	0
Physical Chemistry	0	3	0
Electro-Chemistry	0	3	6
Metallurgy	0	0	3
Hydraulics	0	0	3
Steam	0	3	0
Excursion to southeast Missouri.			
SENIOR YEAR			
LECTURES AND RECITATIONS:			
Alloys	2	0	0
Alternating Current Machinery	0	5	0
Dynamo Machinery	3	0	0
Electro-Metallurgy	2	0	0
Contracts	2	0	0
Metallurgical Problems	1	0	1
Metallurgy	4	4	4
Ore Dressing	4	4	4
Compressed Air	0	2	0
Metallurgy Conference	0	1	0
Metallurgical Organization	0	3	0
Electrical Transmission	0	0	3
Memoirs, Chemical and Metallurgical	0	0	1
Hydraulic Motors and Pumps	0	0	1
Technical Chemical Analysis	0	0	1
LABORATORY WORK:			
Metallurgy and Electro Metallurgy	6	0	0
Ore Dressing	9	0	6
Dynamo Machinery	6	0	0
Compressed Air	0	3	0
Alternating Currents	0	6	0
Metallurgy	0	7	0
Metallography	0	3	0
Electrical Problems	0	0	3
Technical Analysis (Chemical)	0	0	3
Thesis	0	0	6
Senior Trips.			

COURSE III.—CIVIL ENGINEERING

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
General Chemistry	5	5	4
English	5	5	5
Descriptive Geometry	0	2	2
Elementary Mining	2	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry / Analytical Geometry	0	0	5
Mineralogy	0	0	2
LABORATORY WORK:			
General Chemistry	3	3	3
Descriptive Geometry Drawing	0	3	3
Mechanical Drawing	6	6	6
Shop Practice	6	6	0
Mineralogy	0	0	6
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry / Differential Calculus	5	0	0
Integral Calculus	0	5	0
Differential Equations	0	0	5
Advanced English	1	1	1
Spanish, German, or French	5	5	5
Elementary Mechanics	0	2	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
General Physics	0	0	5
Lines of Communication	0	0	2
Geodesy	0	3	0
LABORATORY WORK:			
Field Practice	9	0	9
Forge Shop or Machine Drawing	6	6	0
Geodesy and Computations	0	9	0
Physics	0	0	6
Topography, one week.			

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
JUNIOR YEAR			
LECTURES AND RECITATIONS:			
Astronomy	0	0	2
General Geology	5	3	5
Hydraulics	0	0	5
Mechanics of Engineering	5	0	0
Masonry	0	2	0
Mechanics of Materials	0	5	0
Metallurgy of Iron and Steel	0	0	3
General Physics	5	0	0
Lines of Communication	3	0	0
Thermodynamics	0	5	0
Roads and Pavements	0	0	2
Graphics	0	2	0
LABORATORY WORK:			
Drawing and Graphics	0	0	6
Hydraulics	0	0	3
General Geology	0	3	6
Field Practice	9	0	0
Engineering Laboratory and Graphics	0	12	0
Physics	6	0	0
Steam	0	3	0
SENIOR YEAR			
LECTURES AND RECITATIONS:			
Alternating Current Machinery	0	5	0
Bridges (Higher Structures)	0	5	0
Compressed Air	0	2	0
Dynamo Machinery	3	0	0
Economic Geology	3	0	0
Electrical Transmission	0	0	3
Estimates and Bidding	0	0	2
Framed Structures	2	0	0
Hydraulic Motors and Pumps	0	0	1
Irrigation	0	0	3
Masonry Design and Concrete Steel	0	0	5
Mining Law and Contracts	2	0	0
River and Harbor Improvements	0	0	2
Railroad Economics	3	0	0
Sanitary Engineering	0	5	0
Water Supply	5	0	0
LABORATORY WORK:			
Dynamo Machinery	6	0	0
Alternating Current Machinery	0	5	0
Compressed Air	0	3	0
Designing	0	6	6
Graphics and Engineering Designs	9	0	0
Electrical Problems	0	0	3
Thesis	0	0	6

COURSE IV.—GENERAL SCIENCE

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FRESHMAN YEAR			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
General Chemistry	5	5	4
English	5	5	5
Elementary Mining	2	0	0
German	0	4	4
Mineralogy	0	0	2
Plane Trigonometry	0	5	0
Spherical Trigonometry / Analytical Geometry	0	0	5
LABORATORY WORK:			
Drawing	6	6	6
General Chemistry	3	3	3
Mineralogy	0	0	6
Elective	6	6	0
SOPHOMORE YEAR.			
LECTURES AND RECITATIONS:			
German	5	5	5
English	5	5	5
Elementary Mechanics	0	2	0
Qualitative Analysis	0	2	0
Mineralogy	2	0	0
Elective	6	4	8
LABORATORY WORK:			
Qualitative Analysis	0	6	6
Mineralogy	6	6	0
Physics	0	0	6
Elective	9	6	3
JUNIOR YEAR.			
LECTURES AND RECITATIONS:			
French or Spanish	5	5	5
General Geology	5	3	5
General Physics	5	0	0
Elective	3	10	8
LABORATORY WORK:			
General Geology	0	3	6
General Physics	6	0	0
Elective	9	12	9

SENIOR YEAR.

All elective.

The selection of studies is subject to the approval of the Faculty.

Electives after the Sophomore year must be along one of the two lines: Physics and Mathematics, or Chemistry and Geology. Twenty-three hours recitation, or eighteen hours recitation and five afternoons laboratory work a week, constitute a course.

SPECIAL COURSE IN MINING AND ASSAYING

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FIRST YEAR			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry } Analytical Geometry }	0	0	5
English	5	5	5
General Chemistry	5	5	4
Qualitative Analysis	0	2	0
Elementary Mining	2	0	0
Mineralogy	0	0	2
Elements of Ore Dressing	0	0	3
LABORATORY WORK:			
General Chemistry	9	0	0
Qualitative Analysis	0	9	9
Drawing, Mechanical	6	6	6
Mineralogy	0	0	6
SECOND YEAR			
LECTURES AND RECITATIONS:			
Ore Dressing	4	3	0
General Geology	5	3	5
Mining	0	2	3
Assaying	2	0	0
Plane Surveying	3	0	0
Mine Surveying	2	0	0
Mineralogy	2	0	0
Lithology	0	2	0
Quantitative Analysis	2	0	0
Lines of Communication	0	0	2
LABORATORY WORK:			
Surveying, Field Practice	6	0	0
Ore Dressing	6	0	3
Mineralogy	6	6	0
Lithology	0	3	0
General Geology	0	3	6
Assaying	0	9	0
Quantitative Analysis	6	6	6
Lines of Communication	0	0	3

SPECIAL COURSE IN ELECTRICITY

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FIRST YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry, Analytical Geometry	0	0	5
English	5	5	5
General Chemistry	5	5	4
Electricity and Magnetism	0	3	0
LABORATORY WORK:			
General Chemistry	3	3	3
Drawing, Mechanical	6	6	6
Shop Practice	6	6	0
Physics	0	3	6
SECOND YEAR.			
LECTURES AND RECITATIONS:			
Analytical Geometry, Differential Calculus	5	0	0
Integral Calculus	0	5	0
Differential Equations	0	0	5
Elementary Mechanics	0	2	0
General Physics	5	0	5
Dynamo Machinery	3	0	0
Thermodynamics	0	5	0
Elective	3	3	6
LABORATORY WORK:			
Physics	9	9	9
Steam	0	3	0
Elective	6	3	6

SPECIAL COURSE IN SURVEYING

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FIRST YEAR.			
LECTURES AND RECITATIONS:			
College Algebra	5	0	0
Plane Trigonometry	0	5	0
Spherical Trigonometry / Analytical Geometry	0	0	5
English	5	5	5
Elective	5	5	5
LABORATORY WORK:			
Drawing	6	6	6
Field Practice	0	0	6
Elective	9	9	3

SECOND YEAR.

LECTURES AND RECITATIONS:

Surveying..... 3 hours per week.
Elective.....12 hours per week.
Field Practice..... 9 hours per week.
Drawing..... 6 hours per week.

WATER JACKET BLAST FURNACE

GRADUATE COURSES.

The School of Mines offers graduate work in Mining Engineering, Metallurgy, Ore Dressing, Geology, Economic Geology, Petrography, and Advanced Chemistry. The attention of graduates of engineering schools and of mining schools is directed to the following courses:

Mine Management
Mining Machinery
Mining Machinery Laboratory
Mining Machinery Problems
Mining Law and Contracts
Economic Geology
Geology of the United States
Structural and Metamorphic Geology
Paleontology
Historical Geology
Petrography
Petrography Laboratory
Cement and Concrete Structures
Compressed Air
Engineering Designs
Ore Dressing Laboratory
Ore Dressing Problems
Ore Supply
Metallurgy Organization
Metallography
Constitution of Alloys
Metallurgical Problems
Metallurgical Plant
Metallurgical Plant Design
Cyaniding
Electro-Metallurgy
Electro-Metallurgy Laboratory
Metallurgical Research
Electro-Chemistry
Slag Analysis
Metallurgical Analysis
Technical Analysis
Physical Chemistry
Theoretical Chemistry
Advanced Physico-Chemical Laboratory

GRADUATE COURSE FOR ENGINEERS*

	TIME IN HOURS PER WEEK.		
	FIRST TERM.	SECOND TERM.	THIRD TERM.
FIRST YEAR.			
LECTURES AND RECITATIONS:			
Mine Surveying	2	0	0
Geology	5	3	5
Mineralogy	3	0	0
Lithology	0	2	0
Qualitative Analysis	0	2	0
Assaying	2	0	0
Ore Dressing	0	0	3
Mining	0	2	3
Metallurgy	0	3	3
Elective	6	6	4
LABORATORY WORK:			
Mineralogy	12	6	0
Lithology	0	3	0
Geology	0	3	6
Qualitative Analysis	0	6	6
Assaying	0	0	9
Elective	3	3	0
SECOND YEAR.			
LECTURES AND RECITATIONS:			
Compressed Air	0	2	0
Quantitative Analysis	2	0	0
Economic Geology	3	3	5
Metallurgy	4	4	4
Metallurgy Conference	0	1	0
Ore Dressing	4	3	0
Ore Dressing Memoirs	0	0	1
Mining Law and Contracts	2	0	0
Mine Management	0	0	2
Elective	3	5	5
LABORATORY WORK:			
Quantitative Analysis	6	9	0
Ore Dressing	6	0	3
Compressed Air	0	3	0
Geology	3	0	3
Metallography	0	3	0
Mining Problems	0	0	3
Thesis	0	0	6
Elective	3	3	3

*This two-year course is planned for graduates in Civil, Electrical, or Mechanical Engineering, who desire to work along mining lines. The degree, Mining Engineer, will be conferred on students who have received the Bachelor of Science Degree in Engineering, and who complete the two-year course as outlined.

MATHEMATICS.

PROFESSOR DEAN; ASSISTANT PROFESSOR GARRETT, MR. FORRESTER.

While the utility of mathematical study as a mental discipline is duly recognized, the ultimate intention of the student is kept in mind, and the matter and the method of the courses are adjusted to meet the demands of subsequent studies in pure and applied science.

Students who bring credits from other colleges will be allowed to enter with advanced standing only when the courses can be shown to be equivalent to those given here, and then only conditionally. Those who fail to do creditable work in the courses undertaken, will be required to drop such courses and take up more elementary work.

1. *College Algebra.*—The time allotted for this course being very short, only such work is given as is found absolutely necessary to prepare for subsequent studies.

Freshman year, first term, five hours per week.

Texts: Hawkes, *Advanced Algebra.*
Gibson, *Graphs.*

2. *Plane Trigonometry.*—This subject is the most important in the mathematical equipment of the engineer. The student is drilled, not only in the solution of triangles and other geometrical problems, but in the application of the trigonometric functions to analysis and in shortening computations.

Freshman year, second term, five hours per week.

Text: Taylor and Puryear, *Trigonometry.*

3. *Spherical Trigonometry.*—This course is limited to practical applications in astronomy, geodesy, and mine surveying.

Freshman year, first three weeks of third term, five hours per week.

Text: Taylor and Puryear, *Trigonometry.*

4. *Analytical Geometry.*—This Course includes the study of the straight line, the circle, and special forms of the equations of the conic sections.

Freshman year, third term after Course 3, five hours per week. Text: Ashton, *Analytic Geometry.*

5. *Descriptive Geometry.*—The usual text-book work is reinforced with daily black-board exercises in presenting the projections of familiar objects, intersections of plane and curved surfaces, sections, developments, and shades and shadows. The afternoons in the drawing room are spent in solving in neat form the more elaborate exercises.

Freshman year, second and third terms, two recitations per week, and three hours at the drawing board.

Text: Faunce, *Descriptive Geometry.*

6. *Analytical Geometry.*—This is a continuation of Course 4 and includes the study of the general equation of the second degree, general theorems on conic sections, and the higher plane curves such as the catenary, cycloid, and spirals.

Sophomore year, first four weeks of the first term, five hours per week.

Texts: Ashton, *Analytical Geometry.*
Dean, *Manuscript Notes.*

7. *Differential Calculus.*—The student is given a thorough drill in the derivation of formulae, and application of derivatives and differentials, in the solution of problems in maxima and minima, curve tracing, rates, velocities and accelerations, and expansion of functions.

Sophomore year, first term, five hours per week, following Course 6.

Texts: Osborn, *Calculus.*
Dean, *Manuscript Notes.*

8. *Integral Calculus.*—Attention is paid largely to attaining as much skill as possible in integration of forms occurring in mechanics and physics. As the student acquires his fund of knowledge and experience, he is drilled in evaluating areas, lengths of curves, moments of inertia, and centres of gravity.

Sophomore year, second term, five hours per week.

Texts: Osborn, *Calculus.*
Dean, *Manuscript Notes.*

9. *Differential Equations.*—This course is a continuation of Course 8, taking up more difficult problems, and higher developments of the subject, dynamics of a particle, theory of attraction; and thermodynamics of perfect gases.

Sophomore year, third term, five hours per week.

Texts: Campbell, *Differential Equations;*
Dean, *Manuscript Notes.*

10. *Mechanics of Engineering.*—It is the aim in this course to develop the essential principles of mechanics and to train the student to be proficient in applying them to practical, rather than to theoretical, problems. A large number of problems are solved, which, so far as possible, are selected from machines or structures with which the student is already familiar, or from the study of which he is to make up subsequently.

Junior year, first term, five hours per week.

Text: Maurer, *Technical Mechanics.*

11. *Mechanics of Materials.*—This course includes a study of the theory of stress, strain and elasticity and its application to the design of members of machines and structures; a discussion of the properties of the materials of engineering construction.

Junior year, second term, five hours per week.

Text: Slocum and Hancock, *Strength of Materials.*

Elective Work.

Students in the General Science Course who elect work in pure mathematics will confer with the head of the department, who will arrange work according to the needs, tastes, and aptitudes of the applicants.

The following courses are offered to students who have passed all the required work in mathematics, mechanics, and general physics.

1. Dynamics of Particles and Rigid Bodies.
2. Hydrodynamics.
3. Mathematical Theory of Elasticity.
4. Newtonian Potential Function.

5. Harmonic Functions.
6. Theory of Probability and Method of Least Squares.
7. Differential Equations of Mechanics and Physics.
8. Mechanics of Hoisting Machinery.

CHEMISTRY.

PROFESSOR GOTTSCHALK, ASSISTANT PROFESSOR THOMPSON, MR. HYNES, MR. BARRETT, MR. RIEDE, MR. LANE.

Equipment.

One entire building is given to chemistry. The main chemical lecture room occupies the entire south wing of the building and contains a long lecture desk with gas and water connections for lecture experiments and a large glass hood and side desks fit it for demonstration purposes for large classes. The general chemistry laboratories contain the lockers and desks for one hundred students.

The qualitative analysis laboratory provides desk space for forty students working at one time. A long line of hoods extends along two walls of the room. Air blast is provided and the room is well ventilated by means of a blower. The entire second floor of the building is used for quantitative analysis. The main laboratory will accomodate fifty-two students at one time. Gas and water are supplied conveniently and compressed air furnishes blast for thirteen blast lamps. The balance rooms on the north side of the building contain nineteen first-class balances.

There are several private and research laboratories on both floors.

Courses.

1. *General Chemistry.*—This course is a comprehensive study of the general principles of chemistry and of the more important elements. Special attention is paid to the chemistry of the metals. The Periodic law is followed throughout.

CHEMICAL HALL

The lectures are fully illustrated; the class is divided into several smaller sections for recitations.

Freshman year, first and second terms, five hours per week; third term, four hours per week.

Text: Gooch and Walker, *Outlines of Inorganic Chemistry*.

2. *General Chemistry Laboratory.*—The laboratory work accompanying general chemistry consists of experiments which are largely quantitative, and which are intended to teach stoichiometrical relations from the first.

Freshman year, one afternoon per week throughout the year, Civil Engineering and Mining Engineering Courses; first term, three afternoons per week, Metallurgy Course, and Special Courses in Mining, Surveying, and Assaying.

3. *Qualitative Analysis.*—This course includes lectures and laboratory work; the laboratory work includes the tests and separation of the more common metallic elements; analysis of solutions containing phosphates, of alkaline solutions, of insoluble substances, of alloys, of natural products, and of slags; also blow-pipe analysis.

Lectures, Sophomore year, second term, two hours per week, Mining Engineering and General Science Courses; Freshman year, second term, two hours per week, Metallurgy Course, and Special Courses in Mining and Assaying.

Laboratory work, Sophomore year, second and third terms, two afternoons per week, Mining Engineering, and General Science Courses; Freshman year, third term, two afternoons per week, Metallurgy Course; first year, second and third terms, three afternoons per week, Special Courses in Mining and Assaying.

The same course is given in the summer school.

Text: Treadwell and Hall, *Qualitative Analysis*.

4. *Quantitative Analysis* — Introductory Course. — This work begins with a study of the balance; this is followed by accurate gravimetric analysis, first on pure soluble salts, then on natural products; then by accurate volumetric analysis (acidimetry, alkalimetry, iron by the permanganate method).

As samples of technical work, the wet assays as practiced in the West, are studied during the latter half of the course.

Lectures, Junior year, first term, two hours per week, Mining Engineering Course; Sophomore year, first term, two hours per week, Metallurgy Course and Special Course in Mining and Assaying.

Laboratory work, Junior year, first term, two afternoons per week; second term, three afternoons per week, Mining Engineering Course; Sophomore year, first term, two afternoons per week; second term, three afternoons per week, Metallurgy Course; second year, first term, two afternoons per week; second term, three afternoons per week, Special Courses in Mining, Chemistry, and Assaying.

The same course is given in the summer school.

Text: Miller, *Quantitative Analysis for Mining Engineers.*

5. *Quantitative Analysis Lectures.*—This lecture course comprises a complete exposition of the general methods and details of manipulation of analysis, theory of instruments used, general chemical theory not included in Freshman chemistry, and the discussion of the sources of error, including testing, purification, and preparation of reagents.

Sophomore year, second and third terms, two hours per week, Metallurgy Course.

6. *Quantitative Analysis (Advanced).*—This course is planned to train the student in general methods of technical analysis.

Laboratory work, second year, third term, two afternoons per week, Special Course in Chemistry, Mining and Assaying.

7. *Slag Analysis.*—This course presents the methods for complete analysis of slags of various kinds.

Laboratory work, Sophomore year, third term, four afternoons per week, Metallurgy Course.

8. *Metallurgical Analysis.*—Advanced quantitative analysis in its application to metallurgy and metallurgical processes is presented in the laboratory.

Laboratory work, Junior year, first term, two afternoons per week, Metallurgy Course.

9. *Technical Analysis.*—This is an advanced and applied course in quantitative analysis.

Senior year, third term, one hour per week, Metallurgy Course.

Laboratory work, Senior year, third term, one afternoon per week, Metallurgy Course.

10. *Chemical Memoirs.*—Carefully prepared abstracts of current articles or of special subjects are prepared by the students for this course.

Reports, Senior year, first term, one hour per week, Metallurgy Course.

11. *Electro-Chemistry.*—This course includes a theoretical introduction of the study of electro-chemistry and is followed by applications of principles.

Junior year, second term, two hours per week; third term, three hours per week, Metallurgy Course.

Laboratory work, Junior year, second term, one afternoon per week; third term, two afternoons per week, Metallurgy Course.

12. *Physical Chemistry.*—This is a short course designed mainly as an introduction to the various kinds of chemical equilibria encountered in metallurgical practice.

Junior year, second term, two hours per week, Metallurgy Course.

Laboratory work, Junior year, second term, one afternoon per week, Metallurgy Course.

Graduate Course.

13. *Theoretical Chemistry.*—The application of theoretical chemistry to fundamental metallurgical principles are assuming such prominence and leading to such important results that a knowledge of this subject is indispensable to the metallurgical engineer who desires to keep pace with the de-

velopments in his field. To meet this demand a course for graduate students is offered, presenting the subject of chemical equilibria from the thermodynamic point of view, including a consideration of the technical applications made by Nernst, Le Chatelier, Haber, von Jüptner, and others. The student is expected to do considerable reading of original articles in English, German, and French scientific journals and books.

Graduate Course, first and second terms, two hours per week.

14.—*Advanced Physico-Chemical Laboratory.*—This is an advanced course to accompany the lectures in Theoretical Chemistry, and includes the study and measurements of typical chemical equilibria, either as a repetition of classical researches in this field or preferably on original problems. The equipment for this work includes measuring instruments of the most approved types for high temperature, electro-thermic and physico-chemical work, and special apparatus built in the school shops.

Graduate Course, first and second terms, two afternoons per week.

PHYSICS.

PROFESSOR MCRAE, MR. POLLARD.

Equipment.

The lecture room and laboratories for Physics and Electricity are in Norwood Hall. The lecture room will seat one hundred students and is provided with water, gas, and electric connections for conveniences in lecture demonstrations and experiments.

The physical laboratory is on the ground, or basement, floor. There are two large laboratories, one equipped for general physical measurements in mechanics, sound, and heat, and one equipped for electric measurements. There is a battery room equipped with both primary and secondary batteries connected by wires with the various laboratories and lecture room; a constant-temperature room with double walls and air space insulation; a commodious dark-room with blackened walls for spectrometric and photometric measurements, and a special laboratory for research work.

The equipment includes a Rowland electro-dynamometer with shunts and resistances; a Leeds & Northrup decade wheatstone bridge; a Queen & Co. post-office pattern wheatstone bridge; two portable testing sets; various wheatstone bridges and resistance boxes; standards of resistance inductance and capacity; a Lummer-Brodhun photometer; a Gaertner dividing engine, with linear and circular attachments; a Threlfall micromanometer; a Duddell thermo galvanometer; various tangent mirror and D'Arsonval galvanometers; a Parr coal calorimeter; a wireless telegraph demonstration set; a ten-inch induction coil; Crooke's tubes; X-ray tubes; Toepler Holtz machine; a Schmidt & Haensch spectrometer; a Rowland diffraction grating; photographs of Rowland's normal solar spectrum; Crosby, and Schaeffer and Budenberg steam and gas engine indicators; Amsler planimeters; tachometers and speed counters; various balances; micrometers, calipers, together with apparatus for illustrating the principles of physics.

The dynamo laboratory contains an assortment of direct-current generators and motors, a General Electric double-current generator for direct current and alternating current work, a single and a three-phase generator, an induction motor, a rotary transformer, stationary transformers, three-phase to two-phase transformers and a Cooper-Hewitt mercury vapor converter with testing instruments, which include a Weston laboratory standard volt-meter, with multipliers; a Weston laboratory standard milli-voltmeter, with shunts; a Kelvin electrostatic voltmeter; Weston portable direct-current ammeters; Weston portable direct-current and alternating-current voltmeter; Weston and Thomson portable watt-meters; Thomson alternating-current voltmeters; electro-dynamometers; a Grassott fluxmeter; inductance coils; and condensers.

The power-plant also is used for experimental purposes and comprises a strictly modern and thoroughly equipped laboratory. The machinery available for testing purposes includes three 130-h. p. Heine safety boilers. The steam engines include a 75-h. p. Ideal engine, a 35-h. p. Brownell engine, and a 7-h. p. Davis & Rankin vertical engine. A 15-h. p. Otto gas engine may be belted to electric generators or used for experimental purposes. The pneumatic equipment includes a Laidlaw-Dunn-Gordon air-compressor, a Rand Imperial type air-compressor, a 72-in. ventilating fan, a 36-in. ventilating fan, and a 60-in. Buffalo forge blower. There are six pumps of three different patterns which can be used for power or experimental purposes. The electric generators include a 50-kw. Westinghouse 220-volt direct-current generator, a 3½-kw., 120-volt generator, a 7½-kw. General Electric direct and alternating-current generator, a 2-kw. three-phase Westinghouse generator, and a 1-kw. Westinghouse single-phase generator.

The various electrical motors used for power purposes in the shops and laboratories are available for testing in addition to the machinery in the dynamo laboratory. The total electrical equipment includes thirty-five motors varying in size from ½-h. p. to 30-h. p., with the aggregate rating of 150-h. p.

Courses.

1. *Elementary Mechanics.*—This subject includes the study of the simple machines and the fundamental principles of mechanics and hydrostatics. Lectures are illustrated by experiments and recitations.

Sophomores, second term, two hours per week.

Text: Merriman, *Elements of Mechanics.*

2. *Electricity and Magnetism.*—This course is designed as an introduction of the study of electricity and magnetism.

Lectures and recitations, second term, three hours per week.

Text: S. P. Thompson, *Lessons in Electricity and Magnetism.*

3. *Laboratory Work in Electricity and Magnetism.*—Three afternoons per week throughout the year.

4a. *General Physics.*—The work in general physics begins with the study of kinematics, statics, kinetics, and the mechanics of fluids. The first term's work concludes with the study of heat, including an introduction of thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of such subjects as sound, light, and alternating currents of electricity.

Sophomore year, third term, five hours per week.

Text: Watson, *General Physics.*

4b. *General Physics.*—This course is a continuation of 4a and includes the study of electricity and magnetism, sound, and light. The following subjects are presented in the study of electricity and magnetism: Static electrification, potential, quantity, capacity, resistance, induction, impedance, inductive capacity, and electric waves. During the latter part of the term the reflection, refraction, diffraction, and interference of sound and light are studied. The entire course is illustrated by lecture experiments and supplemented by work in the laboratory.

Junior year, first term, five hours per week.

Text: Watson's *General Physics.*

5. *Laboratory Work in Mechanics, Sound, Light, Heat, Electricity, and Magnetism.*—In the laboratory, the work is quantitative, and aims, as far as possible, to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them.

Sophomore year, third term, two afternoons per week; Junior year, first term, two afternoons per week.

6. *Thermodynamics.* — A short course in theoretical thermodynamics is followed by a study of boilers, furnaces, and heat engines, standard types of safety and tubular boilers, chimney and mechanical draft, pumps, and heaters. Steam, gas, and gasoline engines are also studied. Recitations and lectures are supplemented by the equivalent of one afternoon per week in the steam laboratory, where practice is had in operating and indicating engines; measuring chimney draft, boiler evaporation, and the calorific value of fuels.

Junior year, second term, five hours per week; laboratory work, second term, one afternoon per week.

Text: Reeve, *Thermodynamics.*

7. *Dynamo Machinery.*—This course discusses the magnetic circuit of dynamos and motors, with methods of connecting for operation in series and parallel; characteristic curves, and methods of testing dynamos and motors.

Senior year, first term, three hours per week.

Text: Sheldon, *Dynamo Machinery.*

8. *Alternating Current Machinery.*—In this course typical single and polyphase generators, synchronous and induction motors, stationary and rotary transformers, are studied. The effect of frequency, induction, and capacity upon the impedance of circuit are presented by the graphical and analytical solution of numerous problems in transmission and distribution.

Senior year, second term, five hours per week.

Text: Sheldon and Mason, *Alternating Current Machinery.*

9. *Electrical Transmission.*—This course includes the continuous current circuit, single and polyphase alternating-current transmission, series and parallel distribution, design of the conducting system, and overhead and underground construction. Lectures and recitations supplemented by one afternoon per week in electrical problems.

Senior year, third term, three hours per week.

10. *Dynamo Laboratory.* — During the first term the work is in connection with the course in dynamo machinery and during the second term it is in connection with the course in alternating-current machinery. The work includes the calibration of instruments, characteristic curves, efficiency tests of dynamos, motors, transformers, converters, line resistance, capacity inductance, impedance, and insulation measurements.

Senior year, first and second terms, two afternoons per week.

Graduate Courses.

11. *Theory of Electricity and Magnetism.* — In this course a mathematical treatment of electricity and magnetism is presented for graduates and advanced under-graduates.

First and second terms, three hours per week.

12. *Alternating Currents.* — This course supplements Course 8 and includes an analytical geometrical treatment of the subject.

First and second terms, two hours per week.

13. *Dynamo Design.*—This course is open to those students who have completed Courses 8 and 9 and includes the design of dynamos, motors, alternators, and transformers.

Third term, three afternoons per week.

CIVIL ENGINEERING.

PROFESSOR HARRIS, MR. HOWE, MR. BAUERIS, MR. GARST, MR. PARK.

Equipment.

Civil engineering occupies the greater portion of the third floor, including two large drafting rooms amply lighted and equipped for the work above the Freshman year, a blueprint room, two large lecture rooms, and a department library and study.

The equipment for field practice includes thirteen transits and one theodolite, one plane table, one solar compass, one railroad compass, eleven levels, together with barometers, meters, chains, tapes, level rods, tools, and other necessary equipment for field practice. A number of the transits are adapted for underground surveying.

The experiment room is located on the first floor and is equipped with separate lockers for the equipment of each surveying squad.

The testing laboratory is located in the basement and is equipped with suitable machinery for making tests on engineering materials.

Courses.

1. *Surveying.*—This consists of a course in general surveying, including the use of the transit, the level, and the solar compass. Students are required to plot to scale the areas surveyed and to complete the map in all its details. Following this work, city surveying and topographic methods are taught.

Sophomore year, first term, three hours per week.

1a. *Field Practice.*—Students in Civil Engineering have field practice three afternoons per week during the first and third terms of the Sophomore year; the other students in surveying have field practice two afternoons per week during the first term of the Sophomore year.

1b. *Topography.*—The students are divided into parties, each with a captain, and to each is assigned an area to be covered. One week is given to this work in the Sophomore year. From notes so taken, the Civil Engineering students are required to produce a finished topographic map in the first term of the Junior year.

1c. *Geodesy.*—In this course the student studies higher problems in surveying, including engineering astronomy, base-line measurements, and precise leveling.

Sophomore year, second term, three hours per week, Civil Engineering Course.

1d. *Geodesy — Computations and Drawings.* — In this course the student is given exercises in mapping and platting, in the determination of areas, and in the partition of land. He learns to solve systematically the problems in geodesy.

Sophomore year, second term, three afternoons per week, Civil Engineering Course.

2. *Lines of Communication.*—This course covers the mathematical problems in the location of railways, highways, and canals, and in setting out and estimating earthwork, laying out track, and locating tunnels.

Sophomore year, third term, lectures and recitations two hours per week, Civil Engineering Course; Junior year, third term, lectures and recitations two hours per week, Mining Engineering Course.

Field Practice, Sophomore year, third term, three afternoons per week, Civil Engineering Course; Junior year, third term, one afternoon per week, Mining Engineering Course.

3. *Railway Economics.*—This course treats of the economic principles of railway location and improvements of old lines as affected by curvature grades, first cost, cost of maintenance, and traffic.

Senior year, first term, two hours per week, Civil Engineering Course.

4. *Masonry Construction.* — The course treats of the economic properties of building stone, brick, and cements; the proportioning, mixing, and placing of mortars and concrete; preparation of foundations and strength and stability of masonry structures, including dams, piers, abutments, retaining walls, and arches.

Junior year, second term, two hours per week.

5. *Engineering Laboratory.*—This includes tests determining the strength and properties of building materials of various kinds, including stone, brick, cement, concrete, cast-iron, steel, and wood. Special attention is paid to tests of cement and cement mortar and concrete.

Junior year, second term, two afternoons per week, Civil Engineering Course.

6. *Roads and Pavements.*—This course discusses the principles involved in the location and construction of highways, streets, and roads, and the merits of the various methods of paving.

Junior year, second term, two hours per week, Civil Engineering Course.

7. *Masonry Designs and Concrete Steel.*—This course treats of the higher structures in masonry, including arches, dams, and portals, and the art and theory of concrete-steel structures. The properties, uses, and economy of cement are discussed. The student is required to prepare drawings and specifications of as many structures as possible during the time available.

Senior year, third term, five hours per week, Civil Engineering Course.

8. *Hydraulics.*—This course covers the theory of hydrostatics and of hydraulics; the determination of experimental co-efficients and their use as applied to the flow of water through orifices, weirs, pipes, and canals. Also the theory of hydraulic motors and dynamic pumps.

Junior year, third term, five hours per week.

9. *Water Supply.*—This course covers the selection, impounding, transporting, and delivering of water supply to cities and towns.

Senior year, first term, five hours per week, Civil Engineering Course.

10. *Sanitary Engineering.*—This course treats of the necessary precautions for the protection of water supplies from pollution and the methods available for the purification of contaminated supplies. It also includes a study of the principles involved in the collection and disposal of sewage and storm waters, and sewer construction.

Senior year, second term, lectures and recitations five hours per week, Civil Engineering Course.

11. *Irrigation.*—This is a short course designed to emphasize essential details of the location of canals, headworks, impounding reservoirs, and supplementary work.

Senior year, third term, lectures and recitations three hours per week, Civil Engineering Course.

12. *River and Harbor Improvements.*—This course reviews the control of flood water, the protection of river banks, the improvement of navigation, and the protection and improvement of harbors.

Senior year, third term, lectures and recitations two hours per week, Civil Engineering Course.

13. *Frame Structures.*—This course, designed alike for students in Mining and Civil Engineering, treats of general methods of determining stresses in such structures as single-span bridges, roof-trusses, towers, derricks, and of the design of individual members, as posts, beams, and rods to carry specified stresses.

Senior year, first term, two hours per week, Mining Engineering Course; Senior year, first term, five hours per week, Civil Engineering Course.

14. *Bridges (Higher Structures).*—This course is for students in Civil Engineering only and introduces the study of arches and cantilever, swing, and suspension bridges.

Senior year, second term, five hours per week.

15. *Drawing and Graphics.* — Students in Civil Engineering are required to complete a topographic map during the Junior year. This is followed by an exercise in the elementary problems of graphic statics as applied to single-span bridges and roofs and to masonry structures.

Junior year, second term, four afternoons per week; Junior year, third term, two afternoons per week; Senior year, first term, three afternoons per week, Civil Engineering Course.

16. *Engineering Designs.*—This is a practical course in the design of steel bridges, concrete steel structures, water supplies, and sewage systems.

Senior year, first and second terms, three afternoons per week, Civil Engineering Course.

17. *Special Investigations (Thesis).*—In the third term of the Senior year, all graduating students give two afternoons per week to original investigation in some subject which they select, with the approval of the Faculty.

18. *Compressed Air.*—This course covers the laws governing the compression and piping of air and the application of compressed air to the industries.

Senior year, second term, lectures and recitations two hours per week; laboratory, Senior year, second term, one afternoon per week.

19. *Astronomy.*—A course in general astronomy is given for students in Civil Engineering.

Junior year, third term, two hours per week.

MECHANICAL HALL

MINING ENGINEERING.

DIRECTOR YOUNG.

The School of Mines and Metallurgy offers a regular four-year course in Mining Engineering. At the beginning of the Senior year three options are offered in place of the Senior course of study in the regular Mining Engineering Course.

Equipment.

The surveying equipment already referred to in Civil Engineering is used for mine surveying. The School of Mines has several thousand drawings and blue-prints of mining machinery and mine plants which are used in connection with work in mining and mine management. There are also in the Library a large number of lantern slides and photographs illustrating mining practice in the United States.

The laboratories contain air-compressors, pumps, rock-drills, special drill steel, and models of mine timbering, which are used for demonstration and experimental work.

Courses.

1. *Mining Machinery.* — This option is designed for those students who desire to specialize along the mechanical side of Mining Engineering. Less time is given to metallurgy and geology and more time to machine problems and laboratory.

2. *Ore Dressing.* — This option is designed for those students who desire to specialize in concentration of ores. More time is given to ore dressing, both theoretical and applied, with a correspondingly longer time for laboratory work. Less attention is paid to geology than in the regular course.

3. *Mining Geology.*—This option is designed for those students who desire to specialize along the geological side of mining and gives less time to metallurgy and ore dressing and more time to geology.

The options lead to the common degree of Bachelor of Science in Mining Engineering. The course of study includes the following subjects:

1. *Elementary Mining.*—This short course outlines the principles on which the science of Mining Engineering is founded, and is designed to introduce the student to fundamentals which will enable him to appreciate the applications of the other studies of the Freshman and Sophomore years.

Freshman year, first term, two hours per week.

2. *Mine Surveying.*—The theory and the practice of the surveying of mineral lands and mines are presented by lectures. Many problems are introduced and the student is trained in various calculations, including the reduction of notes of underground surveys requiring the auxiliary telescope, volumes of stopes, mineral acreage, intersections of veins, underground connections, and general problems in the determination of the location of mine openings. A mine surveying trip to the Joplin district is a required part of the work of the Junior year.

Sophomore year, first term, two hours per week, Mining Engineering Course.

3. *Mining.*—This course includes lectures on prospecting, drilling, blasting, boring, tunneling, shaft-sinking, and mining methods. The various tools and appliances used in these operations are described. A review of methods of mine timbering is included in the course.

Sophomore year, second term, two hours per week, Mining Engineering Course.

The same course is given in the summer school.

4. *Mining.*—This course is a continuation of Course 3 and includes lectures in mine haulage, hoisting, mine drainage, mine ventilation, lighting, accidents, and hygiene.

Sophomore year, third term, three hours per week, Mining Engineering Course.

5. *Junior Trip.*—At the end of the school year the members of the Junior class make a three weeks trip to the mining districts of southeast and southwest Missouri. The purpose of the trip is to give an opportunity for the study of the methods of mining and the concentration of ores in the districts visited, together with work in mine surveying and geology.

A complete report of the work of the trip is required.

6. *Mining Law and Contracts.*—The general principles of mining law are reviewed with discussions of legal decisions in representative cases. The students are given the general principles governing the making of contracts, together with discussions of contracts typical of various mining districts.

Senior year, first term, two hours per week, Mining Engineering, Civil Engineering, and Metallurgy Courses.

7. *Mine Management.*—This course is planned to give the student an idea of the principles of management of mining enterprises, and reviews methods of mine organization, mine accounting, and presents economic problems in connection with mine management. The practice of mine examination and mine reporting is reviewed.

Senior year, third term, two hours per week, Mining Engineering Course.

Texts: Rickard, *Economics of Mining.*
Rickard, *Ore Sampling.*

8. *Mining Machinery Laboratory.*—Prior to undertaking laboratory work on special mining machinery, the student is given a thorough training in the machine shop. This work includes chipping to a line, filing to a dimension, and scraping to a surface plate; the principles and uses of the drill-press, planer, lathe, shaper, and milling machine. In this work use is made of the vernier micrometer, thread micrometer, and gear-tooth caliper. The degree of accuracy

thus acquired enables the student to use eye and hand in unison and is of lasting benefit in teaching exactness in statement and measurement.

Special attention is given to various types of mining machinery and to the study of steel and other materials which enter into the construction of such machinery.

Laboratory work, Senior year, first term, one afternoon per week; second term, three afternoons per week, Mining Machinery Option.

9. *Mining Machinery.*—This course includes an outline of the various types of machinery used in mining operations and is planned to familiarize the student with the best designs of machinery in order that he may be able to select the proper machine for the particular condition, that he may know when each machine operates efficiently, and know how to keep the machine in a first-class condition.

The machinery studied includes rock-drills, coal-cutters, mine-hoists, mine-pumps, mine-locomotives, wire-rope haulage systems, mine-fans, excavating machinery, and safety appliances.

Senior year, second term, four hours per week; third term, five hours per week, Mining Machinery Option.

10. *Mining Machinery Problems.*—This course is a continuation of Course 8, and includes advanced work in the machine shop in connection with mining machinery. The methods of testing various machines under working conditions are presented and whenever possible such tests are carefully carried out underground.

Senior year, third term, two afternoons per week, Mining Machinery Option.

GEOLOGY AND MINERALOGY.

ASSISTANT PROFESSOR GRISWOLD, MR. COREY, MR. DON.

Equipment.

The mineralogy laboratories are on the second floor of Norwood Hall. They are equipped with suitable tables for the examination of minerals and rocks. They contain the extensive collections of wooden and glass models and the reference and working mineral collections. The laboratory for lithology contains a representative collection of rocks for reference and a large working collection.

The geological and mineralogical equipment includes a representative collection of minerals, rocks, and fossils for class use; a large collection of cabinet specimens of minerals and ores, and of materials illustrating metallurgical processes. There have been recently added to the equipment of this department several large geological relief models, which aid materially in the work in stratigraphical structural geology.

There is also a collection of thirty-five hundred specimens, representing the mineral wealth of Missouri, consisting of coal, clays of many sorts, and building stones, and ores of lead, zinc, iron and copper. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. There is also a complete collection of the economic minerals of Missouri and a good economic geological collection representing the world at large. This collection was a part of the Missouri Mineral Exhibit displayed at the World's Fair at Chicago. It was presented to the School of Mines and Metallurgy by the General Assembly in 1895.

In addition to the above mentioned collection, the State Board of Equalization assigned to the School the specimens, models, maps, and machinery which constituted the Missouri Mining Exhibit at the St. Louis Exposition, thus giving to the School a large amount of valuable equipment.

The Museums contain crystals and minerals from various important mining districts of the State of Missouri, the economic collections from southwest Missouri, the great geological relief map from the St. Louis Exposition, polished stone tables and other complete collections of the Missouri Building and ornamental stones from the same exposition.

A rock section machine and instruments for geological surveys are included in the equipment of this department.

Courses.

1. *Mineralogy.*—This course consists of lectures and laboratory work. Crystallography is studied first and is followed by the investigation of the physical characters of the minerals. Special attention is given to the ores, gangue minerals, non-metallics of economic value, and the rock-forming silicates.

Lectures, Freshman year, third term, two hours per week; Sophomore year, first term, two hours per week.

Laboratory work, Freshman year, third term, two afternoons per week; Sophomore year, second and third terms, two afternoons per week.

The work of the first two terms is repeated during the summer school.

Text: Dana, *Mineralogy.*

2. *Lithology.*—The course is elementary in character; the igneous rocks are studied with reference to texture and mineral composition, and the sedimentary rocks chiefly with reference to structure.

Lectures, Sophomore year, second term, two hours per week.

Laboratory work, Sophomore year, second term, one afternoon per week.

Text: Kemp, *Handbook of Rocks.*

3. *Petrography.* — The subject is divided into optical mineralogy and lithology. The igneous rocks are first studied, then the sedimentary and the metamorphic rocks. The course

is designed to meet the needs of the mining engineer and the mining geologist. A large amount of time is given to the study and determination of hand specimens.

Senior year, first and second terms, three hours per week; third term, two hours per week, Mining Geology Option Course.

Texts: Kemp, *Handbook of Rocks;*
Iddings, *Rock Minerals.*

4. *General Geology.*—This is a lecture course involving the principles of general and economic geology. It discusses the evolution of the earth, its present condition, and the processes which have modified its crust and surface.

Junior year, first term, five hours per week; second term, three hours per week; third term, five hours per week.

Text: Scott, *An Introduction to General Geology.*

5. *General Geology Laboratory—Structural Geology.*—The student has work upon geological models, maps, and photographs, with the view to interpreting geological structures and land surface forms.

Junior year, second term, one afternoon per week.

Field Work.—The student visits various localities near Rolla with the instructor and has the various types of geology explained; then he is assigned an area to map geologically.

Junior year, third term, two afternoons per week.

The course is supplemented by the summer field excursions to southeast Missouri.

6. *Economic Geology.*—This is a series of lectures dealing with the occurrence, origin, and distribution of ores, clays, building stones, gems, water supply, and other products of economic value from the different geological formations. The characteristics and genesis of ore deposits are carefully considered. The members of this class visit local points of economic importance near Rolla, studying iron, lead, coal, clay, and building-stone, besides making an excursion to the zinc-lead district of Joplin.

Senior year, first and second terms, three hours per week; third term, five hours per week.

Text: Ries, *Economic Geology of the United States.*

7. *Geology of the United States.*—This lecture course considers the various geologic and physiographic provinces of the United States and adjacent areas in the relation to geological development and economic interest.

Optional for Seniors, first term, three hours per week.

8. *Geological Conference.*—The conference consists of a discussion by the students and instructors of geological literature or problems associated with extra reading or with the laboratory work of the term.

Optional for Seniors, second term, two hours per week.

9. *Structural and Metamorphic Geology.*—In this course various type regions of the world are studied in detail with reference to structure, to metamorphism, and to their combinations.

Optional for Seniors, third term, three hours per week.

10. *Senior Geological Laboratory.*—(a). One afternoon per week is given to mapping a local area, the resulting map to be accompanied by a geological report.

Senior year, first term, Mining Engineering Course.

(b). This includes the drawing of maps and sections and some experimental work, planned with reference to the Geological Conference (Course 8) and to Structural and Metamorphic Geology (Course 9).

Senior year, second term, two afternoons per week.

(c). Excursions are made to various localities and economic interest within easy reach of Rolla and also to the Joplin district.

Senior year, third term, one afternoon per week, Mining Engineering Course; optional for Seniors, third term, one afternoon per week.

11. *Paleontology.*—The course is designed to serve as an introduction to historical geology.

Senior year, first and second terms, four hours per week.

Laboratory work, Senior year, second term, two afternoons per week.

Text: Zittel, *Paleontology.*

12. *Historical Geology.*—The stratigraphical development of the United States is taken up in as much detail as time permits.

Senior year, third term, four hours per week.

METALLURGY AND ORE DRESSING.

PROFESSOR COPELAND, MR. DUDLEY, MR. MANN, MR. ANDERSON.

Equipment.

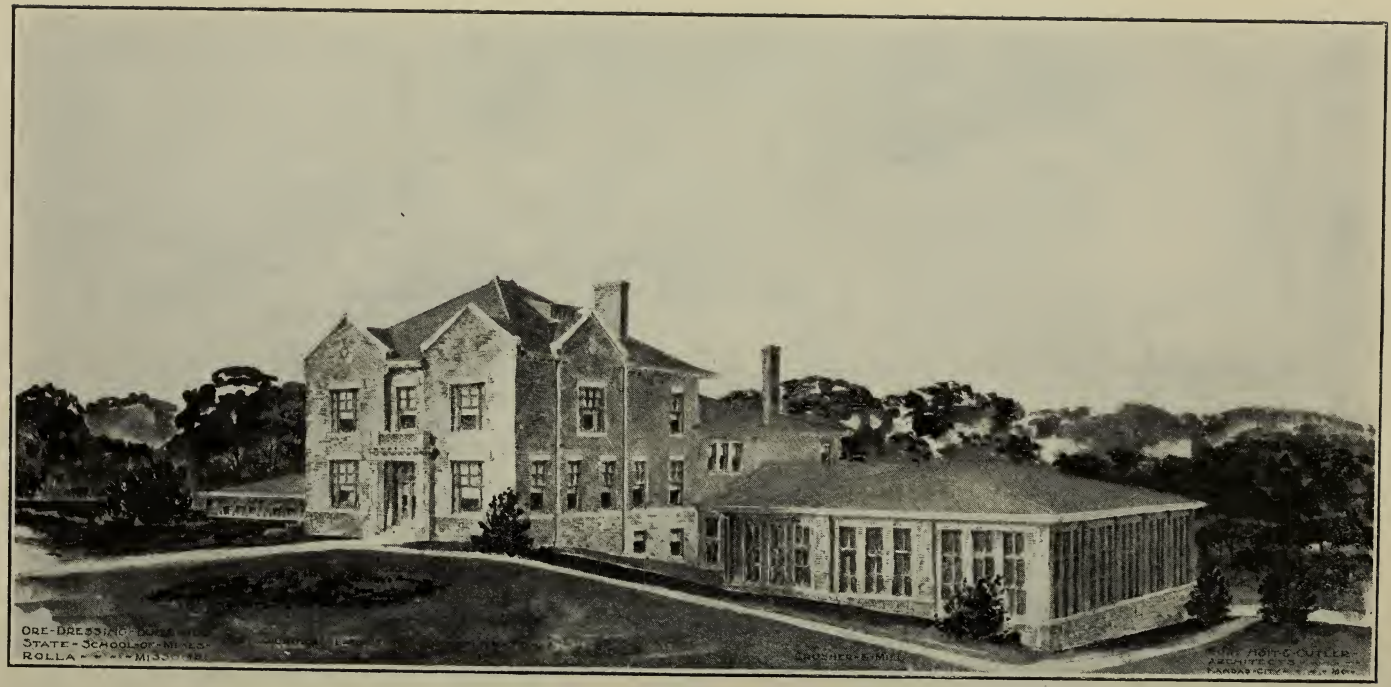
The assay laboratory has a floor space of forty-eight hundred square feet. The main room contains twenty coal-fired double-muffle assay furnaces, twelve gasoline-fired furnaces, and ten coke-fired furnaces. Desks containing lockers, pulp balances, and fluxes are arranged close to the furnaces.

The parting room contains the necessary hot plates, stills, and muffles. The balance room is equipped with eleven fine balances.

The main metallurgy laboratory is well equipped with hoods and sinks and contains fifty-six desks and lockers. This laboratory is used especially for metallurgical testing of various kinds.

The west wing of the Ore Dressing Building is equipped with a 20-inch water-jacket blast-furnace with a Root blower, for reduction of lead and copper ores. There is also in this laboratory an experimental hand reverberatory roaster, an experimental pot roaster, an experimental zinc distilling furnace, a Deville clay-testing furnace, Le Chatlier thermo-electric pyrometers, a Wänner optical pyrometer, a cyanide testing outfit with 100-lb. capacity tanks, a laboratory tube-mill, and laboratory amalgamating pans.

A special ore dressing laboratory is provided for investigation and thesis work. The mill-room is equipped with first-class machinery for the crushing and concentration of ores. The plant contains a Knowles magnetic separator, a Dodge rock-breaker, a Webb City crusher, Cornish rolls, three sets of sample rolls, a stamp-battery with automatic feeder, hydraulic classifiers, Spitzkasten, three New Century jigs, one Standard table, one Card table, one Sperry slimer, Parsons-Rittinger percussion tables, a Frue vanner, grinding and amalgamating pans, and settlers, elevators, and trommels. In addition to this, working models of different types



ORE DRESSING BUILDING

of concentrators have been made by students of the School of Mines and contributed to this outfit. Several thousand blue-prints illustrating the design of concentrating plants and ore dressing machinery are easily accessible in the school library.

Courses.

The work in this department is designed to give students a thorough training in all branches of metallurgy.

It is recognized that a school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim to give such training in the fundamental principles and their application, that students may become useful immediately on their entrance into the actual practice of their chosen profession. All metallurgical courses are accompanied by graded metallurgical problems, which give the student a technical command of the subject.

An important feature of the instruction is experimental investigation in the metallurgical treatment of various ores.

For convenience in recording and reporting, the subjects following are classified under the general letter M, with necessary subdivisions:

M-1. *Fire Assaying.*—This work includes the assay, by scorification and crucible methods, of ores from the various mining districts of the United States. Copper ores, copper mattes, and copper bullions are assayed by fire and by the combination method. Lead ores and furnace products are assayed for lead and for gold and silver. Assays of cyanide solutions, of zinc-box residues, of silver bullion, of gold bullion, of lead bullion, and of silver-mill precipitate, are included in this course. During the course the student has practice with coal furnaces, coke furnaces, and gasoline furnaces. Besides doing the ordinary work of assaying, the student studies the losses occurring. He learns the effects of different schemes of firing the furnaces by making analyses of the flue gases and by pyrometric measurements. The laboratory is so arranged that even with large classes a student

is not hampered by other students and he learns to handle a large amount of work with the best utilization of his time.

The laboratory course is supplemented by lectures. The nature of the processes is thoroughly explained and the practical difficulties are discussed.

The same course is given in the summer school.

Text: Lodge, *Notes on Assaying.*

M-2. *General Metallurgy and Metallurgy of Iron.*—This course begins with general principles, including properties of metals and alloys, fuels, fluxes, calculation of charges, general study and classification of furnaces, followed by a study of processes employed for the production of cast iron, wrought iron, and steel.

Junior year, second and third terms, three hours per week.

Text: Campbell, *Manufacture and Properties of Iron and Steel.*

References: Roberts-Austin, *Introduction;*
Howe, *Metallurgy of Steel.*

M-3. *Metallurgy of Lead and Silver.*—The properties and uses of lead, and of its alloys and compounds, are discussed in this course. A study is made of the principles and practice of sampling and purchasing ores. The major part of the course is given to the consideration of the standard and proposed methods for winning, desilverizing, and refining lead. Great stress is laid on the principles involved, and the student is referred to the text and to current literature for the details of processes. The winning of silver by smelting, amalgamation, and leaching is studied. Especial attention is given to cyaniding of silver ores. Throughout the course there is brought forward the commercial viewpoint as well as the view strictly technical.

Senior year, first term, four hours per week.

Texts: Hofman, *Metallurgy of Lead;*
Collins, *Metallurgy of Silver.*

COAL-FIRED ASSAY FURNACES

M-4. *Metallurgy of Copper, Nickel, Mercury, Tin, Antimony.*—The metallurgy of copper is the principal part of the course. The lectures deal with the properties and uses of copper and copper products, and with the principles employed in the winning and refining of copper. Inasmuch as the metallurgy of copper is continually changing it is necessary for the student to examine carefully the various technical journals and to note the improvements and also the varying conditions affecting the metallurgy of copper.

The metallurgy of nickel, mercury, tin, and antimony are discussed only briefly.

Senior year, second term, four hours per week.

Text: Peters, *Principles of Copper Smelting.*

M-5. *Metallurgy of Gold and Zinc.*—The course in the metallurgy of gold considers the extraction of gold by the standard methods. Especial attention is given to cyaniding. The rapid advances in cyanide practice are discussed in the class room, and laboratory experiments on debated points are encouraged.

The course in the metallurgy of zinc includes lectures on the properties of zinc and its compounds, the concentration of zinc ores, and the manufacture of spelter and of zinc paints.

Senior year, third term, two hours per week.

Texts: Rose, *Metallurgy of Gold;*
Ingalls, *Metallurgy of Zinc.*

M-6. *Constitution of Alloys.*—These lectures deal with the theoretical and practical considerations that influence the structure and properties of alloys of different types.

Senior year, first term, two hours per week, Metallurgy Course.

M-7. *Electro-Metallurgy.*—Lectures are given covering the electro-metallurgical processes that are in use. Efficiency and engineering calculations based on this and the required courses above mentioned.

Senior year, first term, two hours per week, Metallurgy Course.

M-8. *Metallurgical Organization.* — The course briefly takes up the principles of organization and the duties of officers and accounting force of a metallurgy plant. The outline shows the extent of the course. Organization of companies and working forces, management, superintendence, skilled and unskilled labor. Then following this, the constitution of capital, stocks, bonds, dividends, and profits.

Senior year, second term, three hours per week, Metallurgy Course.

Text: Conyngton, *Corporate Management.*

M-9. *Metallurgical Problems.*—These problems aim to cover the common ones that the metallurgist meets in practice. They are carefully chosen so as to represent as typical cases as possible.

Senior year, first and third terms, one hour per week, Metallurgy Course.

Text: Richards, *Metallurgical Problems.*

M-10. *Memoirs.*—The student in the Metallurgy Course is required to do a considerable amount of technical reading in German and English. Carefully prepared abstracts of valuable current articles are presented and read by the students themselves. These articles are chosen by reason of having special value along chemical or metallurgical lines.

Reports, Senior year, first term, one hour per week, Metallurgy Course.

M-11. *Metallurgical Laboratory.*—This course aims to familiarize the student with the use of calorimeters and pyrometers, and their calibration. Some insight is given into the ordinary methods of metallurgical investigation, and the methods of measurement which a metallurgist should know how to conduct.

Junior year, third term, one afternoon per week, Metallurgy Course.

Text: Howe, *Laboratory Notes.*

M-12. *Metallurgy Conference.*—This work is of great value to the student and aids him materially in getting the full value of his laboratory work.

Senior year, second term, one hour per week.

M-13. *Metallurgical Laboratory.* — This course covers the testing of ores for process of treatment. Ores are tested by cyaniding, chlorination, amalgamation, lixivation, concentration, and by combination methods. With aid of smelter schedules, the smelting costs are calculated and the net dollars and cents returns are balanced against the best results by any method, or combination of methods, worked out in the laboratory. The endeavor is made, not only to teach metallurgical principles in the laboratory, but also to bring home to the student the great effect which freight rates and other factors might have on the treatment which an ore should receive. Experiments are made in the reverberatory and "pot" roasting of ores, and on blast-furnace smelting of ores.

Furnace heat-equations are made by each student from data collected by himself.

The same course is given in the summer school.

Senior year, second term, one afternoon per week.

Text: Howe, *Laboratory Notes.*

M-14. *Metallography.*—This is a study of the microstructure of iron and steel and of the effects of heat treatment.

Senior year, second term, one afternoon per week, Mining Engineering and Metallurgy Courses.

M-15. *Metallurgical Problems.*—This course has reference to the designing and proportioning of various types of furnaces for special duties and conditions. It necessitates a clear conception of metallurgical principles.

The alternative, electro-metallurgical problems, will cover the design and estimates for a copper or copper-nickel refinery.

M-16. *Electro-Metallurgy Laboratory.* — This course gives a study of the principles of electro-metallurgy from the standpoint of experiments actually performed. Tests are made on the electrolytic refining of copper and of lead bullion. Experiments are performed and calculations as to efficiency are made on electric smelting.

Senior year, first term, two afternoons per week, Metallurgy Course.

M-17. *Metallurgy Plant.*—The arrangements of various metallurgical works are studied. The advantages and disadvantages of different equipments are given. Throughout the entire course stress is laid on the financial problems.

Graduate course, second term, three hours a week.

M-18. *Metallurgy Plant Design.*—This is a drafting-room course, and the student is given problems to solve in detail, covering a part of the class room discussions. Each student is required to submit complete drawings, specifications, and estimations of cost.

Graduate course, second term, three hours a week; third term, nine hours a week.

M-19. *Cyaniding.*—This course teaches the principles and practice of cyaniding. The student keeps up with the progress in the art. Attention is given in all the work to the costs of operation and to the schemes used and proposed for lessening the cost. A detailed study is made of the types of filter presses, crushing machinery, and other devices used in cyanide mills. Cyaniding is compared with other possible methods of reduction.

Graduate course, first and second terms, three hours a week.

M-20. *Cyanide Laboratory.*—The student in this course has an opportunity to test in the laboratory the methods discussed in the class room. The work is not routine, but the experiments are arranged to bring out a point under discussion or to solve, if possible, the problems occurring at the time in the class room.

ORE DRESSING LABORATORY

Graduate course, first and second terms, six hours a week.

M-21. *Ore Supply.*—This course is intended to bring out the important subject of ore, flux, and fuel supplies. The subject is studied from a combined commercial and technical standpoint. The problems of valuing fluxes and fuels, of mixing ores so that the mixture shall command the lowest treatment rate, and of preparing, from the reduction works standpoint, treatment charges for different classes of ores, are studied.

Graduate course, third term, three hours a week.

M-22. *Metallurgical Research.*—Each graduate student elects a subject for special study. It is recommended that the work be along a different line from the subject chosen for thesis. The course consists principally of assigned reading, together with conferences with the professor on the matter read. The laboratories are always open for the solving of any problem that may arise.

Graduate course, five hours a week throughout the year.

O. D. 1. *Elements of Ore Dressing.*—In this course the principles of all common ore dressing processes are briefly discussed. The various machines used for crushing, classification, and concentration of ores are described. Especial attention is given to those processes and mill schemes which the student has opportunity to see while on the Junior trip.

Junior year, third term, three hours per week.

Text: Richards, *Ore Dressing.*

O. D. 2. *Ore Dressing.*—In this course the principles of mechanical ore treatment are discussed in detail. The construction and theory of machines are presented in lectures, supplemented by a full equipment of models, which show the design of all common ore dressing appliances.

The latter part of the course deals with the management of mills, and with the adaptation of processes to the successful treatment of various ores.

Senior year, four hours per week, throughout the year.

Text: Richards, *Ore Dressing.*

O. D. 3. *Ore Dressing Memoirs.*—The student is required to do considerable reading and to prepare abstracts of articles appearing in the current technical literature. Articles of special interest in ore dressing are assigned for discussion at the weekly conference.

Conference, Senior year, third term, one hour per week.

O. D. 4. *Ore Dressing Laboratory.* — The student becomes familiar with the operation and care of milling machinery by actual laboratory experience. All types and classes of machines are available to illustrate principles and practice as presented in the lecture work. The laboratory is so arranged that a number of mill schemes may be utilized and processes for treating a particular ore can be determined from mill tests on large quantities of the ore.

Senior year, first term, two afternoons per week.

O. D. 5. *Ore Dressing Laboratory.*—This course is more extensive than Course 5. Besides the regular mill practice, the student makes sizing tests upon the products of breakers, and determines the quality of work done by concentrating machines under varying conditions. Each student is assigned independent experimental work involving the theoretical principles, which are of importance in ore dressing.

Senior year, first term, three afternoons per week; third term, two afternoons per week, Metallurgy Course and Ore Dressing Option Course.

O. D. 6. *Ore Dressing Problems.*—In this course advanced work is given in connection with the design of plants and machinery for the treatment of ores. The course includes the determination of a practical process for treating a given ore, and the design of a mill for utilizing this process.

Drafting room work, Senior year, second and third terms, one afternoon per week.

WOOD SHOP

SHOP PRACTICE AND DRAWING.

ASSISTANT PROFESSOR BOWEN, MR. SMITH.

Equipment.

The shops are thoroughly equipped with machinery and benches adapted to instruction. The wood bench work-room contains twenty double benches with separate sets of hand tools. The lathe-room is equipped with twenty Fay & Egan 12-in. swing college wood lathes and iron shears. The other machines in the lathe-room include a Fay & Egan 27-in. planer, a Fay & Egan bandsaw with 30-in. wheels, an Oliver universal saw-table, two Oliver wood trimmers, a mortise machine and jig-saw, grinding saws, and other necessary tools.

For instruction in forge work there are twenty-four Buffalo Forge Company down-draft forges, power hammer, drill-press, power shears, and grinder.

The metal-working room contains

One 20-in. by 8-ft. Reed Lathe.
One 12-in. by 6-ft. Reed Lathe.
One 12-in. by 5-ft. Reed Lathe.
One 14-in. by 6-ft. Hendey Lathe.
One 14-in. by 6-ft. American Lathe.
One No. 2A Brown & Sharpe Universal Milling Machine.
One Hendey 15-in. Pillar Shaper.
One Dwight Sensitive Drill.
One Barnes 22-in. Swing Upright Drill Press.
One 24-in. Morse Double Emery Grinder.
One 24-in. by 24-in. by 6-in. Chandler Planer.
Two Grunard Arbor Presses, No. 3½ and No. 1.
One No. 1 Burr Cold Saw.
One 3-fire Chicago Flexible Shaft Gas Furnace.

All of the above mentioned iron-working machinery is of latest design and driven by individual motors. The benches in the lathe-room have hardwood tops mounted on standard

Brown & Sharpe bench legs. Twenty-four machinist vises, twelve of which have the swivel base and jaw, equip the shop for bench work.

The drawing rooms are equipped with double drawing tables and will accommodate two hundred forty students working in two sections.

Courses.

1. *Wood Work.*—The work in this course begins with simple exercises in planing and marking with the gauge and knife. It continues until the pupil has become thoroughly familiar with the use of the plane, bevel, square, gauge, and knife. He is then given graded exercises covering rip and cross-cut sawing and sawing to a "fit." Following this comes work at joints designed to show the different methods of construction, glue joints, doweling, dove-tails, and braces. This work is supplemented by talks on the tools and work in hand, and each student is required to pass a written examination on notes covering the classification and use of hand tools and accessories.

This preliminary work is followed by the construction of a drawing desk of our own design, which is a very rigid and substantial individual desk. It is designed for two sections, each student having a separate drawer and locker for instruments and drawing board, where they are free from disturbance and dust. Following the desk comes wood turning, which is designed to familiarize the student with the use of the lathe. He is given graded exercises, beginning with a plane cylinder, including curves of various kinds and sizes, and concluding with face plate work in rings, balls, goblets, and vases. On all the preliminary work students are required to use the tools in such a way as to make the use of sandpaper unnecessary.

A final part of this course is cabinet-making, designed to give the student work on the planer, universal saw-table, wood-trimmer, scroll-saw, and mortise-machine. After becoming familiar with the different machines, pattern-making is

FORGE SHOP

begun, the purpose of this work being to teach the student to make representative types of patterns from which castings may be made. The principles of the shrink rule are explained, and drawings, such as are used in manufacturing plants, are made in order to teach the use of the finish marks, core boxes, and all conventional signs.

All work is done from drawings.

Freshman year, second term, two afternoons per week.

2. *Forge Work.**—This course begins with simple exercises in drawing, upsetting, bending, twisting, punching, and welding. The work gradually becomes more difficult, such as making eye-bolts, chains, and tongs. Tool-making is then begun by making screw-drivers, hammers, chisels, and a complete set of lathe tools, which will be used later in the machine shop. This work is fully illustrated by drawings and lectures on the subject, covering the properties of the different grades of iron and steel. The instructors make the student familiar with the best grade of steel to be used for any required purpose, and the correct shape and temper necessary for the best work in cutting iron, steel, brass, and stone. The final and most important part of this work is the testing of rock-drills of different makes, care being taken to preserve the results of the tests on different grades of steel used.

Sophomore year, two afternoons per week during the entire year.

3. *Metal Work.*—This course begins with chipping to a line, filing to a dimension, and scraping to a surface plate. Machine operation is then begun; the principles and uses of the drill-press, lathe, planer, shaper, and milling machine are taught by lectures followed by practical work at each machine. After a reasonable time, skill is attained in operating the various machines through a course of graded exercises. Students are required to build complete machines de-

*Students may elect three terms in machine drawing instead of three terms in forge work.

signed by upper classmen or by the instructor. In this work use is made of the vernier micrometer, thread-micrometer, and gear-tooth caliper. The degree of accuracy thus acquired enables the student to use eye and hand in unison, and is a lasting benefit in teaching exactness in statement and measurement.

This is a part of the course in Mining Machinery Laboratory, described as Course 12 in Mining Engineering.

4. *Mechanical Drawing.*—The student is first given practice in geometrical construction until he is familiar with the nature, care, and use of drafting instruments. Then, after carefully studying the principles of orthographic projection, intersection, and development, he is thoroughly drilled in free-hand lettering. The course is completed with one term of machine drawing. In this the student is required to make sketches, detail and assembly drawings of machines, and is taught the principles of elementary machine design.

Freshman year, six hours per week throughout the year.

Texts: Anthony, *Mechanical Drawing;*
Wilson, *Free-Hand Lettering; Machine Drawing.*

5. *Machine Drawing.**—This course is a continuation of the work in mechanical drawing of the Freshman year. It includes exercises covering gearing, power transmission, mechanism, and the simpler machines used in mining, ore dressing, and metallurgy.

Sophomore year, two afternoons per week throughout the year.

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*Students may elect three terms' work in the forge room instead of three terms' work in machine drawing.

ENGLISH.

MR. SCOTT.

Efficiency in oral and in written expression on the part of the engineer is no longer considered among teachers in technical schools a matter of secondary importance. Efficiency in English, like that in any purely technical subject, can be acquired only by a systematic study of the principles underlying the subject, followed by long apprenticeship of practice under judicious criticism.

No credit for advanced standing in English will be given unless the work for which the credit is asked was done in the collegiate department of an accredited college or in the Junior or Senior year of a State normal school.

1. *Theme Work.*—All Freshmen are required to write, throughout the year, short, daily, and long, fortnightly themes. This work is carefully criticised by the teacher, corrected by the student, and returned to the critic as evidence that the student has profited by the criticisms.

2. *Rhetoric.*—Phases of this subject, too complex for the high school, are studied.

Freshman year, five hours a week throughout the year.

Texts: Brewster, *Representative Essays on the Theory of Style;*
Pearson, *Principles of Composition;*
Baldwin, *College Manual of Rhetoric.*

3. *Advanced English.*—All Sophomores are required to write at least one long theme each month. The forms of composition represented by these themes will be exposition and argumentation. An equal number of subjects are selected from each form and are criticised in the same manner as the Freshman themes.

The work in Advanced English is divided between the critical study of technical literature and the masterpieces of English and American literature, including the literature of some of our best magazines.

Sophomore year, one hour a week throughout the year.

4. *General Science English.*—The major part of the course will consist of the theoretical study of the forms of composition known as exposition and argumentation, with the frequent writing of short and long themes, and occasional oral debates. The study of English and American literature will receive some attention, but the work will be mainly to illustrate ideal exposition and argumentation. A part of one term will be given to the criticism of the language of technical literature as found in scientific journals.

Sophomore year, five hours a week throughout the year, General Science Course.

Texts: Baker, *Argumentation;*
Baldwin, *Exposition;*
Richard, *The Criticism of Technical Literature.*

MODERN LANGUAGES.

MR. WILKINS.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, make at least a reading knowledge of them practically a necessary part of an engineer's education.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue —to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

German (Elementary).—For such students who elect German as the foreign language in their course, and who have not had at least one year of high school German.

Freshman year, second and third terms, four hours per week.

German (Scientific).

Text: Dippold, *Scientific German Reader,* and current scientific journals and magazines.

Sophomore year, five hours per week throughout the year.

French (Scientific).—Students who have not had Elementary French will not be permitted to elect this language.

Text: Herdler, *Scientific French Reader,* and current scientific journals and magazines.

Sophomore year, five hours per week throughout the year.

Spanish.—The growing demand for mining engineers and metallurgists in South and Central America, in Mexico, and in the Philippines, where a knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural or conversational method is followed exclusively. The object is to give the student facility in the every-day speech of the people. With the consent of the Faculty, students may elect Spanish as the required modern language.

Text: Hill and Ford, *Spanish Grammar.*

GENERAL INFORMATION.

Terms and Vacation.

The college year, consisting of thirty-six weeks, exclusive of the Christmas holidays, is divided into three terms. The first term begins September 7 and ends December 22; the second term begins January 4 and ends March 12; the third term begins March 14 and ends June 1.

The Christmas holidays intervene between the first and second terms, but there is no interruption of work between the second and third terms. Thanksgiving Day and Washington's Birthday are observed as single holidays.

The Summer School of six weeks begins June 14 and ends July 24, 1909.

Excursions.

The State of Missouri occupies an important place in the mining industry and many opportunities are offered students at the School of Mines and Metallurgy for keeping closely in touch with the mining industry of Missouri and adjoining States. There have been many important developments during the last few years in methods of mining, dressing, and smelting lead and zinc ores. The lead district of southeast Missouri and the zinc district of southwest Missouri offer numerous examples of up-to-date practice in mining and metallurgical engineering. The aggregate tonnage capacity of the concentrating plants of Missouri is greater than that of any other State of the Union. The importance of modern methods of ore dressing is everywhere recognized and the facilities offered by the School of Mines for investigation in ore dressing, together with the practice in concentrating plants which are visited, places the School of Mines and Metallurgy in the foremost rank in this important branch of mine engineering.

Frequent trips and excursions give the student an opportunity to study mining, ore dressing, and metallurgical methods. Field work in metal mine surveying is carried on in suitable mines conveniently located in southeast and south-

west Missouri. The practice in coal mine surveying is usually given in one of the northern Missouri coal mines or in the Illinois field.

The Junior class visits southeast Missouri to study the geology, methods of mining, and the milling of great disseminated lead deposits. The geological work of the Junior trip is especially valuable because of the variety of work introduced. The class has an opportunity to study several varieties of pre-Cambrian rocks of igneous and other origin. Differentiation in magma and intrusions can be seen. The pre-Cambrian topography is discernible in relation to the contact plane between the pre-Cambrian and the Cambrian. Evidence of superimposed drainage is offered. Iron ores of Shepard Mountain, Pilot Knob, and Iron Mountain give interesting study in the distribution and origin of ores. The general relation of the lead ores of the Paleozoic is also studied. The weathering of various kinds of rock in conjunction with joining and stratification is well illustrated. The Carboniferous basin about St. Louis is given a brief examination. The student should be provided with note-book, compass, clinometer, hammer, and magnifying glass. The observation work of the day is supplemented by evening conferences.

The concentrating plants of southeast Missouri are large and modern, containing crushers, rolls, elevating machinery, Wilfley tables, Frue vanners, jigs, and sundry other machines. The mining plants are thoroughly modern and include steam and electric hoists, modern steel head-frames, compressed air, and electric haulage, extensive pumping-plants, and numerous diamond-drill prospecting equipments.

In southwest Missouri the geology, mining, and milling of the shallow deposits as well as of 'sheet' ground are studied by the Seniors. Opportunity is given to inspect and study the various types of equipment and methods as adapted to shallow and deeper mining. Many new concentrating plants have been erected and are strictly modern in design and equipment. The application of electric power to mining and milling is well illustrated in this district. Short trips are made to neighboring camps in southeastern Kansas.

Special attention is paid on these trips to general engineering problems, plant design, economy of operation, and organization.

During the Senior year several trips are made to the metallurgical plants in the vicinity of St. Louis. The plant of the St. Louis Blast Furnace Company illustrates blast-furnace practice. Here may be studied the blast-furnace, regenerative stoves, blowing machinery, power plant, and other appliances necessary for the production of pig iron. Open-hearth steel methods and the manufacture of steel castings is studied at the Scullin & Gallagher Works. This plant includes in addition to the usual type of open-hearth furnace, Bessemer converters, cupolas, and gas-producers.

The metallurgy of zinc is studied at the Edgar Zinc Works at Carondelet, where the roasting of blende and distillation methods may be seen. The Federal smelter, at Alton, is visited for the study of lead smelting. At this plant the lead blast-furnace, the Huntington-Heberlein roasting system, and the Scotch ore-hearths are carefully inspected. This plant also includes an extensive bag-house. The manufacture of white-lead paint and of lead pipe is seen at the National Lead Works. A further study of lead smelting is made at Herculaneum, where blast-furnaces are served by Savelsberg pot roasters. At the various plants enumerated, particular attention is paid to the construction of furnaces, the operation of the plant, and the general organization and design.

The manufacture of refractory materials is carefully followed from the mine to the finished product at the plant of the Laclede-Christy Company. This plant is one of the largest clay manufacturing works in the world, and a metallurgist here has a splendid opportunity to investigate refractory products and materials used in the construction of furnaces, stacks, retorts, and crucibles.

These excursions are a required part of the courses and no substitutions are allowed. Every candidate for a degree must take the prescribed excursions as scheduled.

Student Organizations.

The following chapters of college fraternities exist at the School: Gamma Chi of Sigma Nu, Beta Alpha of Kappa Alpha, Beta Chi of Kappa Sigma, Alpha Kappa of Pi Kappa Alpha, and Missouri Beta of Tau Beta Pi.

The Young Men's Christian Association was organized in the College several years ago, and is growing rapidly. It stands for the best there is in college life and brings together those who believe that college men should develop well-rounded characters, physical, mental, and spiritual. During the opening days of the college, trains are met by association members, who place themselves at the service of the new men, helping them to secure rooms and board and to matriculate. The Association occupies the second floor of the Mining Building, where all students are welcomed and regular meetings are held.

The School of Mines Band furnishes music for athletic and outdoor functions and maintains a splendid organization.

The School of Mines Orchestra is reputed throughout south central Missouri as without equal and furnishes music for all School entertainments, the Commencement Exercises and gives concerts in nearby towns.

Other Student Organizations include the Glee Club, the Mandolin Club, the Mathematical Club, and the International Club.

The student body publishes a year-book called 'The Rollamo.' The purpose of this volume is to record the student activities and to present a review of college life at Rolla.

Athletics.

The School encourages rational athletics and has provided an instructor in physical training who has entire supervision of the physical training of students and of all intercollegiate sports. Occasional privileges are granted to athletic teams, but prolonged absences from work are not permitted.

An athletic field has been enclosed and graded for baseball, football, and other games, and an ample number of tennis courts have been laid out, and are maintained in good order. Suitable dressing-rooms and shower baths are provided in a temporary building on the athletic field. A gymnasium is provided on the second floor of Mechanical Hall. Suitable gymnasium apparatus is supplied and indoor games can be carried on during the winter months. A general athletic association exists among the students, also football and baseball teams, and a tennis club.

Athletic Fee.—Each student is requested to pay a fee of Five Dollars to the Athletic Association of the School.

Expenses.

Tuition Fee.—Tuition is free to all students who are residents of Missouri. At a meeting held in October, 1908, the Board of Curators voted that "From and after September 1, 1909, non-residents of Missouri who matriculate in any Department of the University be required to pay a tuition fee of $20 per year."

Laboratory Fees.—The fees charged are as follows: A Library fee of $5 per year, payable upon entrance; a laboratory fee in general chemistry to cover the cost of gas and supplies; $3 per term for all courses except Metallurgy and Special Mining, for which courses the fee is $10; a laboratory fee in qualitative analysis of $7.50 per term to cover the cost of general supplies and gas; a laboratory fee for quantitative analysis and other Senior and Junior chemical laboratory work, $1.75 per term; a fee of $2.50 per term to cover the cost of supplies for shop work; a fee of $2 per term to cover the cost of supplies in forge work; a laboratory fee of $12.50 per term to cover the cost of supplies in assaying; a laboratory fee of $3 per term to cover the cost of supplies in mineralogy; a fee of $5 per term for Senior metallurgy laboratory; a fee of $2.50 per term for mining machinery laboratory.

Contingent Deposits.—Deposits to cover the cost of extra supplies and damage to apparatus are required of the different classmen as follows: Freshmen, $10; Sophomores, Juniors, and Seniors, $15. These deposits must be renewed if at any time exhausted, and at the end of the school year whatever sum may remain to the credit of the depositor is returned to him.

Living Expenses.—The expenses of many students for the entire year do not exceed $250, which will cover in a reasonable manner the fees, cost of books and stationery, board and lodging, and laundry. The cost of field excursions is not included in the above estimate.

Excursion Expenses.—The cost of field excursions will average about $35 per year.

BUREAU OF GEOLOGY AND MINES.

The Geological Survey of the State of Missouri has its quarters at the School of Mines and occupies the east half of the Rolla Building.

BOARD OF MANAGERS.

Governor Herbert S. Hadley, ex-officio; Professor E. M. Shepard, Springfield; Elias S. Gatch, St. Louis; L. F. Cottey, Edina; C. L. Whitener, Fredericktown.

OFFICERS OF THE GEOLOGICAL SURVEY.

H. A. Buehler, State Geologist.

Equipment.

The Survey has well equipped quarters in the Rolla Building on the School of Mines campus and is furnished heat and light by the School.

The Survey has under its control at the present time a library of five thousand books and pamphlets bearing on Geological subjects, and a museum collection of nearly six thousand specimens of the various clays, coals, fossils, and other geological products of the State. The Geological Survey carries on systematic field work throughout the State by means of its efficient corps of geologists. Reports of this work are printed for distribution among parties interested. Geological maps of the State and of a number of districts have been prepared.

DEGREES CONFERRED 1908.

Engineer of Mines

Joseph Jarvis Brown, Jr., B. S., 1905.
Gustavus Duncan, C. E., 1874.
James Albert Gregory, B. S., 1905.
Elmer Cooper Heck, B. S., 1905.
Ray Eugene Hoffman, B. S., 1905.

Bachelor of Science (Mine Engineering).

Richard Edward Armstrong,
Ralph Robert Benedict,
George Hewitt Boyer,
Elston Everett Jones,
Felix Anthony Lyneman,
Harold Thomas Mapes,
Frederic Arnold Moore,
Alfred Leo Nye,
Miles Sedivy,
Clyde Rex Wood,
Charles Armstrong Baker,
John Hyer Bowles,
Horace Asahel Johnson,
George Fred Kellogg,
Horace Tharp Mann,
Ward Barr Mix,
Edwin Phelps Murray,
John Joseph Sandford,
Edwin Bryant Thornhill,
Frank Lewis Leonard Wilson.

Bachelor of Science (Civil Engineering).

James Duncan Fowler,
Don Morgan Neer,
Paul Andrew Philippi,
Hyman Zirulick.

Bachelor of Science (General Science).

Boyd Dudley, Jr.,
Charles Lewis French,
Frank William Harper,
Herman Carl Hase,
Dibrell Pryor Hynes.

THESES IN 1908.

Lead Smelting on the Ore Hearth, - - - JOSEPH J. BROWN, JR.

Process of Treating Slimes in Ore Reduction, - GUSTAVUS A. DUNCAN.

Report of the Boquillas Del Carmen Mines, of Coahula, Mexico,
JAMES A. GREGORY.

Copper Smelting in a Rotary Furnace with Pulverized Charcoal,
ELMER C. HECK.

Square Set Timbering as Employed by the Shannon Copper Company,
RAY E. HOFFMAN.

The Mining and Milling of a Low-Grade Copper Ore,
HORACE A. JOHNSON AND RICHARD C. ARMSTRONG.

The Effect of Copper on the Cupellation of Silver and Gold,
CHARLES A. BAKER AND MILES SEDIVY.

Desulphurizing or Pot Roasting of Lead Ores,
RALPH R. BENEDICT, EDWARD P. BARRETT, AND FRANK W. HARPER.

The Effect of Tellurium on the Cupellation of Silver and Gold,
HORACE T. MANN, EDWIN P. MURRAY, AND JOHN H. BOWLES.

Test of School of Mines Water and Light Plant,
GEORGE H. BOYER, LELAND R. WALKER, AND ALFRED L. NYE.

An Investigation of the Treatment of the Silver Ore by Lixivation of Sodium and Cuprous Thiosulphate Solutions, - ELSTON E. JONES.

Test of Rolla Water and Light Plant,
WARD B. MIX, GEORGE F. KELLOGG, CLYDE R. WOOD, AND EDWIN B. THORNHILL.

The Development of a Lead and Zinc Prospect, - FELIX E. LYNEMAN.

Treatment of a Mexican Copper Ore, - HAROLD T. MAPES.

The Effect of Arsenic on the Assay of Gold and Silver Ores,
ROSCOE C. HAM AND FREDERICK A. MOORE.

Lime Roasting of a Copper Concentrate and Treatment in the Blast Furnace, - - - FRANK L. L. WILSON.

The Effect of Common Minerals on the Volatilization of Silver Chloride,
BOYD DUDLEY, JR.

Geology of the Cambrian-Carboniferous Unconformity in the vicinity of Rolla, - - - DIBRELL P. HYNES.

The Effect of Antimony on the Assay of Gold and Silver Ore,
HERMAN C. HASE AND CHARLES L. FRENCH.

Graphical Representation of Compressed Air Formulae,
PAUL A. PHILIPPI.

Design of Main Street Reinforced Concrete Arch over Frisco Railroad,
HYMAN ZIRULICK.

Design of Water and Power Plant on Little Piney River,
FRANK L. FLYNT AND JAMES D. FOWLER.

Design of a Reinforced Arch over Frisco Railroad at Tenth Street, Rolla, Mo., - - - - DON M. NEER.

Report on the Shattuck and Arizona Mine, Bisbee, Ariz.,
JOHN JOSEPH SANDFORD.

GIFTS TO THE SCHOOL OF MINES

Aetna Powder Co... ....Chicago, Ill.
Cabinet of explosive samples.

American Bridge Co... ....New York, N. Y.
Two pictures of head frames.

Atchison, Topeka & Santa Fe Ry. Co. ....Chicago, Ill.
Framed picture.

Atha Tool Co. ....Newark, N J.
Prospecting picks and hammers.

Autolyte Manufacturing Co ....New York, N. Y.
Samples of fuse.

Bausch & Lomb Optical Co ....Rochester, N. Y.
One skeleton transit for drafting room.

Branham, W. G ....Joplin, Mo.
Minerals from Bisbee, Ariz.

Brown Hoisting Machinery Co. ....Cleveland, Ohio.
Three framed photographs.

Burdick, C. A ....Dansville, N. Y.
Minerals from Cobalt, Ontario.

California Cap Co ....Oakland, Cal.
Literature on blasting.

Carnahan Mfg. Co . ....Denver, Colo.
Blue-print of rock-drill.

Carnegie Steel Co ....Pittsburg, Pa.
Samples of iron and steel.

Chicago Pneumatic Tool Co ....Chicago, Ill.
Blue-prints of rock-drills.

DeWaters, R. H ....Grant City, Ill
Samples of corn products.

Economic Machinery Co ....Denver, Colo.
Prints of rock-drills.

Fay, A. H ....Brooklyn, N. Y.
Collection of rocks from New York City and vicinity.

Fairbanks, Morse & Co ....Denver, Colo.
Blue-print of rock-drill.

Farrell Foundry & Machinery Co ....New York, N. Y.
Blue-prints and framed photographs.

Fraser, K. C. ....Lyndonville, N. Y
Fossils from New York.

Gardner Electric & Machinery Co. ..... Cleveland, Ohio.
Blue-prints of rock-drills.

Griswold, Professor L. S. ..... Rolla, Mo.
Ores from Nevada; rocks from Decaturville, Mo.; iron ores from Iron and Shepard Mountains, Mo.; fossils from Gasconade and carboniferous formations near Rolla.

Hase, H. C. ..... Morenci, Ariz.
Analyzed samples of ore.

Heller Bros ..... Newark, N. J.
Two bars of drill-steel.

Ingersoll-Rand Co. ..... New York, N. Y.
Blue-prints of rock-drills.

Jeffrey Mfg. Co. ..... Columbus, Ohio
Blue-print of rock-drill.

Jones, J. W. ..... Webb City, Mo.
Analyzed zinc ores.

Kibe, H. C. ..... Davenport, Ia.
Copper ore from Northern Ontario, lead and zinc ores from Magdalena Mountains, New Mexico.

Leyner Engineering Works Co ..... Littleton, Colo.
Blue-print of rock-drill.

Murphy, B. F. ..... Bonne Terre, Mo.
Specimens from iron fissure vein in Southeast Missouri.

New York Central Railroad Co. ..... New York, N. Y.
One picture.

Seamon, W. H. ..... Chihuahua, Mexico.
Analyzed samples of ore.

Sullivan Machinery Co. ..... Chicago, Ill.
Two blank bits, two drawings of rock-drills.

Star Electric Fuse Works ..... Wilkesbarre, Pa.
Samples of electric explosives.

Stephen Humble ..... London, England.
Model of detaching safety hook.

The Ensign-Brickford Co. ..... Simsbury, Conn.
Samples of mining fuse.

Union Pacific Railroad Co. ..... St. Louis, Mo.
Framed pictures.

Westinghouse Electric Co. ..... St. Louis, Mo.
Twenty-five lantern slides.

Wright, J. W. & Co. ..... St. Louis, Mo.
Pictures of machines.

Zerger, H. F. ..... Columbia, Pa.
Specimens of chrondodite and garnet.

STUDENTS AT THE MISSOURI SCHOOL OF MINES AND METALLURGY

1908-1909

GRADUATE STUDENTS.

Ambler, John Owen* ..... Cananea, Mexico.
B. S. in M. E., 1906, School of Mines.

Burgher, Mark Bernardie* ..... Hannibal, Mo.
B. S. in C. E., 1905, School of Mines.

Delano, Lewis Alfred* ..... Bonne Terre, Mo.
B. S. in M. E., 1904, School of Mines.

Dudley, Boyd, Jr. ..... Rolla, Mo.
B. S. in G. S., 1908, School of Mines.

Forbes, Carroll Ralph ..... Topeka, Kans.
E. M., 1903, Michigan College of Mines.

Foster, Leo Joseph* ..... Montrose, Colo.
B. S. in M. E., 1904, School of Mines.

Horner, Preston King* ..... Ely, Nev.
B. S. in M. E., 1906, School of Mines.

Hunt, Lamar Horatio* ..... Mercur, Utah.
B. S. in M. E., 1905, School of Mines.

Hynes, Dibrell Pryor ..... Rolla, Mo.
B. S. in G. S., 1908, School of Mines.

Lintecum, Charles Lafayette* ..... Telluride, Colo.
B. S. in M. E., 1905, School of Mines.

Long, James Carter ..... St. Louis, Mo.
B. S. in M. E., 1907, School of Mines.

Mann, Horace Tharp ..... Rolla, Mo.
B. S. in M. E., 1908, School of Mines.

Murray, Edwin Phelps ..... Fosterville, Wis.
B. S. in M. E., 1908, School of Mines.

Quinn, Matthew Vincent* ..... Quartzburg, Idaho.
B. S. in M. E., 1905, School of Mines.

Rivera, Ramon* ..... Guadalajara, Mexico.
B. S. in C. E., 1906, School of Mines.

Rucker, Ray Fleming* ..... Hannibal, Mo.
B. S. in M. E., 1906, School of Mines.

Smith, Charles Dosh* ..... Webb City, Mo.
B. S. in Chem., and Met. 1905, School of Mines.

Steinmesch, Jesse Herman* ..... Desloge, Mo.
B. S. in M. E., 1906, School of Mines.

Wilfley, Clifford Redman* ..... Hostotipaquillo, Mexico.
B. S. in M. E., 1906, School of Mines.

*In Absentia.

SENIORS.

Anderson, Hector George Sylvester.....Vancouver, B. C.
Barrett, Edward Phillip.....Hastings, Neb.
Baueris, William Albert.....Chicago, Ill.
Beard, John Warren (C. E. Syracuse University).....Syracuse, N. Y.
Boyer, Fred Tete.....St. Louis, Mo.
Butler, Reginald Henry Brinton.....South Woodford, England.
Cavazos, Enrique.....Saltillo, Mexico.
Chamberlain, Ernst Lorenz.....Rolla, Mo.
Clark, William Newton.....Jewell City, Kans.
Clarke, William Danels.....Rolla, Mo.
Compton, James Crawford.....Independence, Mo.
Dobbins, Walter.....Urbana, Ill.
Don, DeForrest.....Rock Island, Ill.
Dunn, Theodore Saunders.....Waukegan, Ill.
Easley, George Albert.....Walker, Mo.
Elicano, Victoriano.....Masinloc, Zambales, P. I.
Garst, Harvey Oden.....Cabool, Mo.
Hall, William Simpson.....Independence, Kans.
Ham, Roscoe Conkling.....Kansas City, Mo.
Hinsch, Van Buren.....Davenport, Iowa.
Hughes, Victor Harmon.....Sabetha, Kans.
Illinski, Alexis Xavier.....Nashville, Tenn.
Jochamowitz, Simon (E. M., School of Mines of Peru).....Lima, Peru.
Keniston, Carl Winthrop.....Plymouth, N. H.
Kibe, Harry Clay.....Davenport, Iowa.
Ladd, Hammond.....Rolla, Mo.
Leming, Paul Bauchmann.....Cape Girardeau, Mo.
Loveridge, Frank Richard.....Rochester, N. Y.
McCrae, Rowe Francis.....Rolla, Mo.
McElroy, William.....Fort Scott, Kans.
Mazany, Mark Stephen.....Dunkirk, N. Y.
Michael, Pearl Frederick.....Rolla, Mo.
Nachtman, Frank.....Junction City, Kans.
Ohnsorg, Norman Lloyd.....Rolla, Mo.
Pollard, Arthur Lewis.....Batavia, N. Y.
Shah, Aaron Max.....Vilna, Russia.
Smith, Earl McColloch.....Little Rock, Ark.
Walker, Leland Ross.....St. Louis, Mo.
Watson, Ralph Wilheim.....Salt Lake City, Utah.
Wishon, Albert Emory.....Fresno, Cal.
Wolf, Edgar Joseph.....Mt. Vernon, Ind.

JUNIORS.

Allen, Robert Sexton.....Kansas City, Mo.
Andrews, Sanford William, Jr. .....Arcadia, Mo.
Blake, Frank Orris, Jr.....St. Louis, Mo.
Blaylock, Daniel Webster.....Flat River, Mo.
Bodman, John Whittlesay.....Kansas City, Mo.
Boland, Earl Frederick.....Syracuse, N. Y.
Bowles, James Joseph.....Lake Springs, Mo.
Branham, William Grover.....Joplin, Mo.
Bunten, James.....Canon City, Colo.
Burdick, Charles Adrian.....Dansville, N. Y.
Callaway, Scott David.....Nevada, Mo.
Caples, Russell Bigelow.....Glasgow, Mo.
Clark, John Charles.....Chicago, Ill.
Connelly, Harry Wade.....Independence, Kans.
Detweiler, Alfred Nicks.....Lebanon, Mo.
Detweiler, Milan Harrison.....Lebanon, Mo.
Diaz, Emilio.....Santiago, Chili.
Dosenbach, Benjamin Harrison.....St. Louis, Mo.
Farrar, Monroe.....Mattoon, Ill.
Forman, John Kavenaugh.....McFall, Mo.
Fraser, Keith Colt.....Lyndonville, N. Y.
Gray, Howard Dean.....Wausem, Ohio.
Gregory, Clay, Jr.....Joplin, Mo.
Haataja, Charles Leo.....Helsingfors, Finland.
Harlan, John Dee.....Moberly, Mo.
Harrison, Walter Edward.....Salem, Mo.
Holmes, Oliver Wendell.....Rolla, Mo.
Jobes, Charles Taylor.....Kansas City, Mo.
Judy, Philip Smith.....Camp Point, Ill.
Karte, Anton Frederick.....De Soto, Mo.
Kenney, John Richardson.....Chicago, Ill.
Killian, Ralph Daniel.....Perryville, Mo.
List, Elmer.....Cape Girardeau, Mo.
McColloms, Max Reed.....Newton, Iowa.
McNutt, Vachel Harry.....Monroe City, Mo.
Mackey, Robert William.....Waukegan, Ill.
Miller, Christian R., Jr.....Sedalia, Mo.
Minor, Harmon Edwin.....Canon City, Colo.
Mook, Robert Lee.....St. Louis, Mo.
Morgan, Allen Ray Dearborn.....Rolla, Mo.
Murphy, Benton Franklin.....Bonne Terre, Mo.
Park, Albert.....Rolla, Mo.
Peterson, Howard Kelsey.....New Rochelle, N. Y.
Pickering, John Lyle, Jr.....Springfield, Ill.
Pierce, Colwell Arba.....Kansas City, Mo.

Porri, Louis Joseph.....St. Louis, Mo.
Porth, Harry William.....Kansas City, Mo.
Radovich, John Christopher.....Bisbee, Ariz.
Riede, Fred Edward.....Canon City, Colo.
Schmidt, Sidney Randolph.....Chicago, Ill.
Schultz, John Elmer.....Topeka, Kans.
Shaw, Albert Henry.....St. Louis, Mo.
Smith, Duncan Slater.....Rockford, Ill.
Smith, Harvey Edson.....St. Louis, Mo.
Smith, Van Hoose.....Little Rock, Ark.
Stewart, John Sloane, Jr.....Mansfield, Ohio.
Thompson, Reuben Conrad.....Sioux Falls, S. D.
Thornberry, Martin Harmon.....Rolla, Mo.
Traughber, Charles Weaver.....Centralia, Mo.
Twyman, George Thomas, Jr.....Independence, Mo.
Vogt, George C.....Davenport, Iowa.
Welsh, Harold Llewellyn.....Kansas City, Mo.

SOPHOMORES.

Abbott, Edward Reese.....Mansfield, Ohio.
Abernathy, George Elmer.....Willow Springs, Mo
Adams, Henry Farnum.....Prescott, Ariz.
Albertson, Maurice Merton.....Aurora, Mo.
Allen, Ernest James.....Forrest, Ill.
Beach, James Keller.....Kansas City, Mo.
Bingham, Raymond Alexander.....Watertown, Mass.
Blake, True Walter.....Maywood, Ill.
Boza, Hector.....Lima, Peru.
Bradt, Albert Leonard.....St. Louis, Mo.
Chase, James Howard.....Logansport, Ind.
Coaske, Paul Ephraim.....St. Louis, Mo.
Cody, Benjamin Horace.....St. Joseph, Mo.
Coover, Louie Lincoln.....Springfield, Mo.
Copeland, Robert Nathaniel.....Chelsea, Mass.
Elmore, Carlos.....Lima, Peru.
Engelmann, Edward William.....St. Louis, Mo.
Fey, Don Frederick.....Burlington, Iowa.
Flynn, Frank James.....St. Joseph, Mo.
Ford, Harold Percy.....St. Joseph, Mo.
Forrester, David Lawton.....Oakland, Cal.
Garcia, Herman.....Mexico City, Mex.
Gosrow, Ralfe Cleveland.....Buffalo, N. Y.
Grosberg, Alex.....St. Louis, Mo.
Groves, Frank W.....Des Moines, Iowa.
Harris, Deane Dwight.....Rolla, Mo.

Holm, William Miller.....Chicago, Ill.
Jones, Howard Hiltz.....Kansas City, Mo.
Kline, Duane Montgomery.....Rolla, Mo.
Kurz, Adolph.....St. Louis, Mo.
Lamadrid, John Manuel.....Sancti Spiritus, Cuba.
Lunak, Otto Allen.....St. Louis, Mo.
McElherne, James Charles.....Rock Island, Ill.
Macomber, Sumner Cooley.....Des Moines, Iowa.
Mann, Frank Clark.....Springfield, Mo.
Mitchell, Robert Bruce.....Walker, Mo.
Nachtman, Ralph.....Junction City, Kans.
Nason, Stanley Lewis.....West Haven, Conn.
Ormsby, Robert Graham, Jr.....Kansas City, Mo.
Overstreet, Chester Zearl.....Indianapolis, Ind.
Pudewa, Arthur Gustav.....Chicago, Ill.
Raj, Shiv.....Lahore, India.
Randolph, Oscar Alan.....Kansas City, Mo.
Scoates, Richard.....South Milwaukee, Wis.
Strong, Arthur Leon.....Lyons, Mich.
Stroup, Thomas Andrew.....Lewistown, Mo.
Tedrow, Harvey Louis.....St. Joseph, Mo.
Townsend, Frank Edgar.....Belgrade, Mo.
Williams, Conway Guild.....Jackson, Mo.
Wolf, Harold Max.....Mt. Vernon, Ind.
Zimmerman, George Henry.....Romney, W. Va.

FRESHMEN.

Bilderback, Alexander Scott.....Kansas City, Mo.
Blake, Harold.....St. Louis, Mo.
Bland, John Lilburn.....Lebanon, Mo.
Bower, Albert.....Mattoon, Ill.
Bowles, Rupert.....Durant, Okla.
Bribach, Oscar Nicholas.....St. Louis, Mo.
Broughton, Eugene Harding.....Jefferson City, Mo.
Castillon, Tirso.....Torreon, Mexico.
Conover, Cairy C.....Carrollton, Mo.
Cronk, Arthur Harrison.....Omaha, Neb.
Cushwa, Claude Calvin.....Independence, Mo.
Deacon, Arthur P.....Webster Groves, Mo.
Diaz, Washington Theodore.....Santiago, Chili.
Dunkin, John Haskell.....Guthrie, Okla.
Durkee, J. B.....Kansas City, Mo.
Elbert, William.....St. Joseph, Mo.
Farrell, Oliver.....St. Louis, Mo.
Gray, Walter Berry.....Louisiana, Mo.

Greensweight, Robert.....Rolla, Mo.
Hackwood, Arthur Willesley.....Baxter Springs, Kans.
Hayes, Dale Irwin.....Rock Island, Ill.
High, Howard Herman.....Faulkner, Kans.
Hollister, Scoville Edward.....Marshall, Mo.
Houseknecht, Seward Forward.....Batavia, N. Y.
Irwin, Joseph Stewart.....Louisiana, Mo.
Johnston, Mead.....Okmulgee, Okla.
Kerr, Andre Joseph.....St. Louis, Mo.
Kinney, Robert Noel.....Rolla, Mo.
Kranzthor, Fred Otto.....Eagle Pass, Texas.
Leavitt, James Blaine.....Washington, D. C.
Lynton, Edward.....Ipswich, England.
Lyons, Clyde Francis.....Springfield, Mo.
McFadden, Edwin Cook.....Chicago, Ill.
McKibben, Harold Dennis.....Kansas City, Mo.
McNair, Stuart Strathy.....New York City.
Meeker, Samuel Ezra.....Pekin, Ill.
Michelsen, Thomas Henry, Jr.....Hobart, Ind.
Morris, Edwin Robinson.....Jefferson City, Mo.
Myers, Warren Prescott.....Prescott, Ariz.
Naylor, Arch Waugh.....Marshall, Mo.
Newton, Lloyd Charles.....Gurdon, Ark.
Parent, George Lee.....Marshall, Mo.
Plessner, Albert.....Holden, Mo.
Porri, William.....St. Louis, Mo.
Porter, Jerome.....Hannibal, Mo.
Purcell, Robert Crofts.....St. Louis, Mo.
Rachal, Frank C.....Falfurris, Texas.
Radcliffe, Donald Hewson.....St. Louis, Mo.
Raible, Norman William.....Hannibal, Mo.
Robinson, Eugene Charles.....Independence, Mo.
Royden, Frank Applegate.....Edgewood, Iowa.
Runnels, Ralph Willard.....Kansas City, Mo.
Schilling, George William.....Freeport, Ill.
Schmich, Matt.....Freeport, Ill.
Shaw, Harry.....St. Louis, Mo.
Shaw, Thomas Edward.....West Haven, Conn.
Sherry, Homer Kent.....Lyndon, Kans.
Smith, Marshall Raymond.....Rolla, Mo.
Smith, William Bryce.....Baxter Springs, Kans.
Stephenson, William Pittman.....Nevada, Mo.
Sudhoff, Ralph William.....Richmond, Ind.
Thomas, George Sylvester.....Chicago, Ill.
Trenkel, Willie Max.....Rolla, Mo.
Tway, Robert Raymond.....Springfield, Mo.

Ustick, Edward Thomas . . . . . St. Louis, Mo.
Vanderhoff, Ralph Scovell . . . . . Vandalia, Ill.
Wafer, James Oscar . . . . . Greenville, Ill.
Wemhaner, Oscar Christopher . . . . . Warsaw, Ill.
Wright, Oscar Conway . . . . . St. Louis, Mo.
Yelton, Erastus . . . . . Rolla, Mo.

SPECIALS.

Chowning, James William . . . . . St. Louis, Mo.
Fort, Albert Sidney . . . . . Rolla, Mo.
Hanes, James Edward . . . . . Wheeling, W. Va.
Hauber, Ben . . . . . Springfield, Mo.
Heydecker, Coral T . . . . . Waukegan, Ill.
Johnesee, Frank . . . . . Greenfield, Ill.
Jones, William Hamilton . . . . . St. Louis, Mo.
Martin, Harry H . . . . . Fredericktown, Mo.
Owen, Harvey Skidmore . . . . . St. Louis, Mo.
Siegmund, Walter Finney . . . . . St. Louis, Mo.
Wright, Clark Watson . . . . . St. Louis, Mo.

ENROLLMENT BY STATES AND COUNTRIES.

Arizona	3
Arkansas	2
California	2
Colorado	5
Connecticut	2
District of Columbia	1
Idaho	2
Illinois	29
Indiana	6
Iowa	7
Kansas	13
Massachusetts	2
Michigan	1
Missouri	128
Nebraska	2
Nevada	1
New Hampshire	1
New York	12
Ohio	3
Oklahoma	3
South Dakota	1
Tennessee	1
Texas	2
Utah	2
West Virginia	2
Wisconsin	2
British Columbia	1
Chili	2
Cuba	1
England	2
Finland	1
India	1
Mexico	6
Peru	3
Philippine Islands	1
Russia	1
Total	254

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